ASTM BULLETIN

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"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

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Forty-second Annual Meeting, June 26 to June 30, Inclusive

Twenty-three Sessions Scheduled

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May, 1939

THERE are a number of very significant factors of interest in connection with the Society's Forty-second (1939) Annual Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, beginning Monday, June 26, and extending through Friday, June 30. One is the fact that this will be the first meeting in Atlantic City to be accompanied by an Exhibit of Testing Apparatus and Related Equipment. Further details of the Exhibit and of the Second A.S.T.M. Photographic Competition, another feature of the meeting, are given on another page of this BULLETIN.

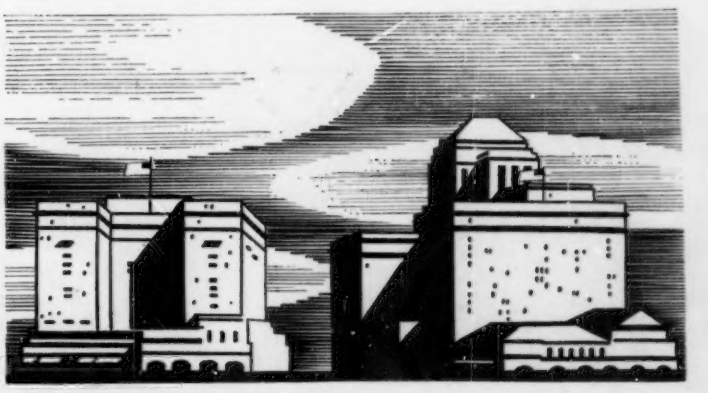
Another point of interest is the unusual number of round-table discussions and symposiums. This "round-table" type of discussion is not new to A.S.T.M. meetings, but having so many of them is distinctly noteworthy and possibly indicative of an increasing appreciation of the need for informal interchange of information on the properties or testing of materials.

It will be noted from the Provisional Program appearing in this BULLETIN that twenty-three technical sessions in all, including the round-table discussions, have been necessary to provide for the many items, particularly if there is to be adequate discussion which usually proves to be such a valuable part of these meetings. The formal opening session is scheduled for 10:30 on Tuesday morning, June 27, all day Monday being reserved for committee meetings, with the Exhibit opening on Monday noon. The opening session will be featured as previously by the annual address of the President, recognition of forty-year members, this ceremony having been instituted last year when the Society was forty years of age. Arrangements are under way to select a speaker of outstanding repute to present a short address also at this session.

On two occasions the tentative program provides for triple simultaneous sessions on topics on which there can be very little conflict of interest.

Continuing the policy of past years, the Edgar Marburg Lecture will be delivered on Wednesday afternoon at four o'clock, this year's Lecture, the fourteenth of the series, being given by Prof. H. F. Moore of the University of Illinois, as announced elsewhere.

Following the Lecture, the Thirteenth Award of the Charles B. Dudley Medal will be made. The Medal Committee consisting of M. F. Sayre, *chairman;* C. H. Davis and C. H. Scholer, has selected as the winner R. W. Carlson, Associate Professor of Civil Engineering, Massachusetts



Institute of Technology, for his outstanding paper presented at the 1938 annual meeting on the subject "Drying Shrinkage of Concrete as Affected by Many Factors." Selection was made "for able work in developing a simple logical theory of concrete shrinkage, in testing that theory by a series of carefully planned experiments, and in presenting the results in a clear and convincing manner in his paper. It is the belief of the committee that he has made a real contribution to the knowledge of concrete as a building material, which should prove valuable in the rational design of concrete structures."

Since the Vernon Room and Garden Room on the Lounge Floor will house the Exhibit, the technical sessions will be held in the Rutland Room on the floor just above the Lounge and use will be made of the meeting room facilities of the Thirteenth Floor, probably using the Viking and Benjamin West Rooms as occasion necessitates. There is also the possibility that a set of three rooms on the first floor now being rearranged by the hotel will provide a convenient set-up for technical sessions, adjacent to the Rutland Room and near the Registration Headquarters. The latter will, as in recent years, be located in the Lounge Floor Parlors, one floor above the hotel lobby. This site has been found eminently satisfactory, providing, as it does, a compact and convenient set-up in the center of the meeting activities, with plenty of lounge space in a pleasant setting for the informal get-togethers which mean so much to the members.

The Annual Golf Tournament will be held on Thursday afternoon. Further details of the tournament will be sent to the members in a special circular at the end of May at which time instructions concerning entry for the tournament, etc., will be announced.

TECHNICAL FEATURES

Frequently, it is possible to single out some symposium or series of papers scheduled for the meeting and say that "this" or "that" is the outstanding feature. This year selection is not easy; in fact, it is not possible because the program is so well balanced.

The attention of the members is especially directed to the Provisional Program in this issue. It includes synopses of the various reports and papers that are scheduled for the meeting, the only place where these synopses will appear.

The symposiums and round-table discussions include a Symposium on Shear Testing of Soils with several papers by outstanding authorities, scheduled for Wednesday evening. The second session of the meeting on Tuesday afternoon is the technical Symposium on Paint Testing, with ten or more outstanding men scheduled to lead discussion. Those concerned with the application of metals at low temperatures, in such fields as refining, railroads and others, and of course all metallurgists, will want to be present at the round table being sponsored by the Joint Committee on Effect of Temperature, on Tuesday night, featuring an open forum on low-temperature applications.

Growing recognition of the importance of quantitative spectrochemical analysis is evidenced by the scheduling of a round-table discussion in three parts on Thursday morning, afternoon and evening. On Thursday afternoon there is to be a discussion on freezing and thawing as related to aggregates and masonry materials.

The two sessions scheduled at 1:30 o'clock Wednesday afternoon preceding the Marburg Lecture (four o'clock) are set up with proper consideration of the time available. It will be noted from the program that the sessions on cement and concrete, lime and gypsum and the non-ferrous metals are scheduled for Friday morning and afternoon, this period having met with the approval of quite a number of members concerned with those fields.

Attention should be called to the group of papers being presented on the subjects of water, fatigue, iron, rubber, gaseous fuels, non-destructive testing including radiography, and on bituminous road materials, all these subjects being of interest to large groups of the members and the engineering fraternity in general.

PREPRINTS SENT ON REQUEST

In a separate mailing there is being sent to each A.S.T.M. member in good standing a Preprint Request Blank by which he can request a copy of any of the technical papers and reports preprinted in advance of the meeting. This blank should be returned promptly and should be carefully marked, with the signature and mailing address of the member clearly indicated. The Provisional Program will enable members to make a selection of the items desired. Preprints will be forwarded to the members, probably in three installments. *Members should note that preprints will not be sent unless requested.*

HOTEL RESERVATIONS, ADVANCE REGISTRATION

It is desirable that all members should make their hotel reservations promptly and for this purpose a return blank addressed to the hotel management, Chalfonte-Haddon Hall, is being sent in a separate mailing. Rooms can be secured on either the American or European plan at the special rates listed on the return blank. Since Chalfonte and Haddon Hall

At the 1938 Meeting: (Left) A Typical Get-Together; (Center) Three Generations; (Right) An Early Morning Chat

each has its own dining room service, members who wish to dine together should secure accommodations in the same division of the hotel, particularly if they are registered on the American plan.

In order to expedite registration of members at the meetings, it is desirable to have as many registration details as possible taken care of in advance and it would be very helpful if members would fill out and mail promptly to A.S.T.M. Headquarters the advance registration card that is being sent.

REGISTRATION PROCEDURE

Members and visitors should register at the A.S.T.M. desk as promptly as possible after their arrival at the hotel. Each member will receive his badge, a copy of the final program and preprints of any of the papers and reports desired. The customary members' registration fee of $1 will be in effect. Visitors will receive the badge and program, and may secure preprints for any two sessions of the meeting. The visitor's fee is $1, but if a complete set of preprints is desired they may be procured by the payment of $1 additional.

WORLD'S FAIR—RAILROAD RATES

There is every indication that an unusual number of members from the West and Middle West will be coming to the meeting this year, probably a good many bringing their families and combining attendance at the meeting and visits to the World's Fair in New York City. Undoubtedly, those members who will travel by rail will investigate the special rates which have been established since these may provide for considerable savings. In all cases transportation can be arranged to permit stop-over privileges at Atlantic City. Full details can of course be obtained from local railroad ticket offices.

We again wish to remind those members who plan to visit the World's Fair that it is important to make hotel reservations early since most of the hotels expect to be filled to capacity. If any difficulties are encountered in making reservations, we understand that accommodations can be secured through the American Express Co. or other tourist agencies, since the American Express Co. and others have already arranged for blocks of rooms and are advertising special tours of the Fair, quoting all-inclusive rates for two, three, four, and five-day tours.

H. F. Moore—Marburg Lecturer

Stress, Strain and Structural Damage

THE Fourteenth Edgar Marburg Lecture will be delivered at the Annual Meeting in Atlantic City on Wednesday afternoon, June 28, by Herbert F. Moore, Professor of Engineering Materials, University of Illinois. Professor Moore will cover in his lecture various types of structural damage and discuss in detail the value of our common test results as prophecies of resistance to structural damage.

In discussing the scope and subjects to be covered in his lecture, Professor Moore has submitted the following statement:

> In the process of developing elaborate mathematical analyses of stress and strain, and of devising reproducible tests for strength of materials there is constant danger that the testing engineer will become so absorbed in his technique of analysis and tests that he will forget their significance to the maker and user of materials.
>
> In the "good old days" the problem of structural damage seemed rather simple. Materials had an "elastic limit" which corresponded to a definite stress measured in pounds per square inch, or kilograms per square millimeters. If the stress was below this limit no damage was done to the material. If the stress was above this limit at any point, no matter how localized, damage had been done. This is perhaps a slight simplification of the idea of the former generation of testing engineers, but it is not very far from a true statement. Today we realize that practically none of those assumptions are rigidly true, that there are many kinds of structural damage, and that the existence of any one criterion for judging resistance to all of them is rather doubtful.
>
> The metallurgist with his microscope and with his X-ray defraction apparatus has shown that the internal structure of materials is far more complicated than our former simplified assumptions. In fact, the structure of materials seems so complicated that so far no mathematical analyst has had the hardihood to propose rigid formulas which fit all these new viewpoints. We admit that our formulas are "Statistical"—like life insurance predictions, and that our tests at best are guides which have a high probability of usefulness in selecting materials.

HERBERT FISHER MOORE

Professor Moore is a graduate of the University of New Hampshire, B.S., 1898 and of Cornell University, M.E., 1899 and M.M.E., 1903. After serving as instructor at Colby Academy, N. H., and at Cornell University, and as mechanical engineer for Riehle Bros. Testing Machine Co., he went to the University of Wisconsin as Instructor and Assistant Professor of Mechanics for the period from 1904 to 1907. He joined the staff of the Department of Theoretical and Applied Mechanics at the University of Illinois in 1907 and since 1922 has been Research Professor of Engineering Materials. Most of his time at Illinois has been devoted to research in the properties of materials and in methods of testing.

He is the author of several books, including "Textbook on Materials of Engineering," "Endurance of Metals Under Repeated Stress," "Fatigue of Metals" (co-author), and "Materials" (Section of Merriman's Handbook); also of about thirty Bulletins of Illinois Engineering Experiment Station and of numerous articles in the technical press. He is a member of the American Society of Mechanical Engineers, Society for the Promotion of Engineering Education, American Association for the Advancement of Science (past v.p.), and British Institute of Metals. In 1930 he was Medallist of the Iron and Steel Institute. He was awarded the honorary degree of Doctor of Science by the University of New Hampshire in 1922.

A member of the Society since 1903, Professor Moore

1938 Meeting: (Left) Messrs. Jeffries, Franks and Russell; (Center) B. L. McCarthy and daughter; (Right) Messrs. Lester and McCormick

served on the A.S.T.M. Executive Committee from 1919 to 1921, was Vice-President, 1925 to 27, and President in 1927 to 28. At the 1938 annual meeting his many contributions to the field of engineering materials and the work of the Society were recognized by the award of Honorary Membership. One phase of his valuable work for the Society has been in connection with the activities of Committee E-1 on Methods of Testing, of which he has been a member for over 20 years. He is the present chairman of the subcommittee on mechanical testing and the section on calibration of testing machines and apparatus. He has served as chairman of the Research Committee on Fatigue of Metals since its organization in 1928 and was the first chairman of the Society's Committee E-9 on Research, serving for ten years until 1934.

1939 Exhibit of Photography

Theme: Testing and Research in Engineering Materials

ONE of the features of the annual meeting will be the Second A.S.T.M. Photographic Exhibit and Competition on the theme—"Testing and Research in Engineering Materials." This will comprise photographs of apparatus, instruments, testing procedures and the like and also eligible are photographs showing unique or unusual application of materials. A separate section of the Exhibit is to be devoted to photomicrography, this being under the auspices of Committee E-4 on Metallography. Details of the Exhibit were published in the March BULLETIN. An entry blank, including the simple rules which have been established, may be secured by anyone interested. Photographs in the general section are to be judged on the basis of portrayal value and also timely interest and importance of subject matter.

Quite a number of members and associates are interested in photography and it is hoped that many of these will submit photographs.

The First Photographic Exhibit held last year at the annual meeting brought forth many favorable comments. It demonstrated some of the fine work that has been done in this field, at the same time stressing the value of photography in technical work.

The photographic exhibit and competition also has another desirable point, namely, to raise the standard of illustrations in technical papers and reports. Quite frequently poor illustrations mar the effectiveness of a paper and while most writers make adequate use of illustrative material, there is room for continued improvement. There is no question that often a clear well-composed photograph will express much more clearly and concisely various matters needing explanation than a great amount of text can do.

All entries and photographs for the Exhibit should be sent to the chairman of the Photographic Committee, Mr. J. P. Eldridge, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. A note to A.S.T.M. Headquarters will bring promptly Entry Blanks with exhibit details.

Fifth Exhibit of Testing Apparatus and Related Equipment

Held in Conjunction with Annual Meeting; Many New Developments in Scientific Apparatus and Laboratory Supply Fields; Numerous Research Exhibits to Be Sponsored

MANY interesting new developments in the field of scientific instruments and apparatus and laboratory supplies will be featured at the Society's Fifth Exhibit of Testing Apparatus and Related Equipment to be in progress at Chalfonte-Haddon Hall, Atlantic City, during the week of the A.S.T.M. Forty-second Annual Meeting, extending from Monday, June 26, through Friday, June 30. A good many of the leading commercial companies concerned with the manufacture and distribution of testing apparatus and related equipment, measuring and recording instruments, laboratory supplies and related scientific instruments will display their products. Several committees of the Society are planning to sponsor displays, directing attention to various phases of their work, and a number of research institutions will be invited to take part.

The Exhibit will be held in the Vernon Room and Garden Room on the Lounge Floor. The official opening will be at noon, Monday. Tentatively it is planned to have the Exhibit open one or two evenings during the week.

The equipment on display will include instruments and apparatus used in testing and research investigations on all kinds of materials, metals, cement, concrete, paints and paint materials, petroleum products, paper products, rubber products, soils, etc. While much of the apparatus is designed for A.S.T.M. tests, there will also be a considerable portion as in the past that has not been standardized, but which is in wide use.

Displays sponsored by committees of the Society have always been an important part of the Exhibit, and this year will be no exception as will be noted from the brief descriptions of committee displays which follow. In these booths will be apparatus not produced commercially, but which is being considered or used in various work, and other material of interest in connection with various committee problems.

In addition to the committees listed, others may participate. Committee C-12 on Mortars for Unit Masonry is contemplating a display of apparatus used and proposed for testing the workability of mortar. There are various types of instruments in use for determining this property.

The material which follows is not complete since it is expected a number of additional booth displays will be included, but it does provide some conception of the widespread fields to be covered in the Exhibit.

Subcommittee VIII of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys

Under the auspices of Subcommittee VIII on Galvanic and Electrolytic Corrosion, there will be displayed actual samples of corrosion test specimens in the form of discs, which have been on exposure for seven years at nine test stations in various parts of the country. There will be two groups of test couples involving some 28 combinations of non-ferrous metals and alloys. One group consisting of a set from each location has been cleaned and weighed. The other sets will be displayed as received from the test location. With the specimens will be explanatory material including actual tables of data so that members and visitors can have a complete picture of the important results to date.

Committee C-5 on Fire Tests of Materials and Construction

In cooperation with the Forest Products Laboratory, Madison, Wisconsin, there will be displayed a fire tube used in testing work, supplemented by charts and descriptive material. The National Bureau of Standards will cooperate also, exhibits including transparencies showing the time-temperature curve with colors to indicate temperature as well as the Fahrenheit and Centigrade scales. It is expected there will also be equipment from the Bureau used in fire tests of flameproofed textiles, together with panels and photographs showing equipments and results of tests.

Committee D-17 on Naval Stores

Apparatus to be included in the display of this committee includes a photoelectric photometer for measuring the chromaticity and brightness of rosin colors as a basis for grading. The instrument is also applicable to grading turpentine. This apparatus was developed in the U. S. Department of Agriculture in conjunction with the development of rosin standards. Subcommittee I on Softening Point of Rosin offers as an alternate a shouldered ring for the apparatus in the Tentative Method of Test for Softening Point by Tapered Ring Apparatus (E 28 – 36 T). This ring is necessary for certain high softening rosins and resins which may slip through the tapered ring on cooling.

Subcommittee XII on Turpentine, of Committee D-1 on Paint, Varnish, Lacquer and Related Products:

This group will display a hydrometer reading direct pounds per gallon of turpentine, with the temperature correction tables. This hydrometer was developed by the U. S. Department of Agriculture.

Committee D-18 on Soils for Engineering Purposes

The exhibit of shear testing equipment will be of particular interest because of the Symposium on Shear Testing of Soils which is being presented under the auspices of Subcommittee VII on Methods of Testing for Shearing Resistance of Soils. Several of the papers in the symposium will refer to new types of shearing equipment and stabilometers and it is anticipated that the exhibit will include some of the instruments and apparatus described in these discussions. A number of organizations not represented in the symposium are also showing new devices and modifications of older methods. Those interested in new equipment will find this a rare opportunity to study the developments in this field.

Committee E-4 on Metallography

As announced in connection with the Photographic Exhibit and Competition a separate section is being developed by Committee E-4 to feature work in the field of photomicrography and its various branches. This display will illustrate the breadth of work being done in this field. The photomicrographs are to be judged and awards will be made to the most outstanding ones.

Committee E-7 on Radiographic Testing

Through the courtesy of the Eastman Kodak Co. there will be displayed a presentation of the story of radiography depicting various important points in connection with this type of non-destructive testing. This display will be of interest to those who are now concerned with radiography and many others who while interested are not at present using it. A set of radiographic standards recently adopted by one of the government divisions for castings may be displayed and other material of interest in the field in which Committee E-7 is active will be included.

List of Companies in Instruments and Related Fields, with Brief Notes on Displays

American Instrument Co. Washington, D. C.

This company will have on exhibition a line of testing equipment for soils, cement, concrete, bitumen, rubber and other items of interest to the membership of the A.S.T.M. These will include the new soil dispersion apparatus, triaxial compression device, stabilometer, shear machine, compressometer, permeameter, and compaction kit for soils. The new DuPont oscillograph for testing the vibration absorption qualities of rubber will be shown in operation. Many other new and useful developments will be shown.

Baldwin-Southwark Corp. Philadelphia, Pa.

On display will be a variety of its materials, testing machines, and instruments. Featured will be the Southwark-Tate-Emery 5-50. This development utilizes the Tate-Emery null method servo-operated long scale indicator combined with a lapped ram and cylinder unit. This type of indicator has been available only on the more elaborate Southwark-Emery capsule machines. The extraordinary sensitive indicator provides an unusual scale length of 270 in., the pointer making five complete turns of 10,000 lb. each. The Carpenter torsion impact machine, the R. R. Moore fatigue tester, and the baby rayflex for electro dynamic fatigue testing of full size specimens will also be displayed.

Bausch & Lomb Optical Co. Rochester, N. Y.

In the testing of materials to insure their compliance with specifications, optical instruments play an important part. The microscope in its various forms, the spectrograph, the colorimeter and the refractometer are invaluable equipment in the testing laboratory.

The Bausch & Lomb Optical Co. will exhibit typical examples of these and other instruments used in the testing of metals and alloys, pigments, textiles and fibers and other materials that must meet A.S.T.M. specifications.

Christian Becker, Inc. New York City

Magnetically damped balances giving automatic readings from 1/10 mg. to 100 mg., plus and minus, fill the need for rapid accurate weighing. Sales of dial reading Chainomatic balances still increase, constant eye level readings and speedy handling of weighings from 0 to 100 mg. appealing to users. Keyboard Chainomatics and balances with heavy capacity and extreme sensitiveness are meeting with success. Many other types of balances are available and special balances can be developed to fit particular needs.

Brabender Corp. Rochelle Park, N. J.

The Plastograph—a recording plastometer based on the dynamometer principle and practically "weighing" the plasticity of different materials—will be shown for the first time. The instrument can be used to measure consistency over a wide range of materials from a fairly viscous, syrupy substance to unvulcanized rubber and has been applied successfully in research as well as in plant control in the following industries: rubber, celluloid, artificial silk, photographic film, activated carbon, fertilizer, paint, starch, dextrin and glue factories, as well as for the testing of soils for highway building.

Central Scientific Co. Chicago, Ill.

The display of the Central Scientific Company this year will feature some new items of equipment for the testing laboratory, as well as recent developments of apparatus and equipment displayed in previous A.S.T.M. exhibits, notably in the field of spectroscopy, photoelectric photometry, and cement testing.

Eimer & Amend, Inc. New York City

A selection of instruments will be featured from their complete stock of laboratory apparatus according to A.S.T.M. specifications. This will include penetrometer for asphalt or grease; brass molds for cement; Cleveland and Pensky-Martin flash testers for oil; Reid bomb for vapor pressure of gasoline; preformed gum in gasoline apparatus; and other laboratory apparatus of new design, such as the Andreasen particle size apparatus, the Tramm absorption pipette, and testing instruments applicable to textiles, paper, rubber and leather.

The Electric Tachometer Corp. Philadelphia, Pa.

In their display this company will feature their Recorder. This Recorder is a gear-driven, electrically operated machine for making a permanent record of speed or production, and time of operation. The record is produced on a wax-coated chart. They will also exhibit indicating tachometers, and their high-speed electric counter.

Federal Products Corp. Providence, R. I.

The most complete line of dial indicators and gages offered. Over five sizes of regular or circular type dial indicators are available. Over six different styles of indicators will be on display together with over sixty different indicator models including the new super-sensitive indicators employing bellows and spring arrangements, which supplement the usual dial indicator construction, as well as the Federal low-friction type of indicator. Many types of dial indicator gages will be shown including a new gage for checking compressibility of fine printing papers and a new type of cylinder gage constructed on an entirely new principle.

Henry A. Gardner Laboratory Washington, D. C.

This Laboratory is manufacturing special apparatus for testing the physical properties of paint, varnishes and lacquers. The following are some of the testing equipment: bubble viscometers; hardness rockers; film forming equipment—Dry-O-Graphs, Film-O-Graphs; impact testers; weight per gallon cups; color standards; tensile strength and elongation apparatus; multi-purpose reflectometers; gloss meters; and special gloss and reflection measuring equipment. Special apparatus for other purposes is made to order.

Kimble Glass Co. Vineland, N. J.

The booth display of this company will be based on its extensive line of laboratory glassware. Kimble Blue Line Exax Retested ware includes a large number of items used in connection with standardized tests and other control, analysis and research work in the field of materials.

Since the main office and manufacturing plant of this company is a short distance from Atlantic City, a cordial invitation is extended to all A.S.T.M. members and others interested to visit the plant at Vineland. Needed transportation facilities will be made available. The representatives in the Kimble booth will be glad to make the necessary arrangements and provide further information.

Leeds & Northrup Co. Philadelphia, Pa.

Of particular interest is an operating demonstration of a new recording photoelectric microphotometer. The record, made in ink by the new Speedomax recorder, has a very open scale approximately 25 cm. wide. The spectrographic plate is traversed at various speeds, commonly at from 1 to 5 mm. per minute. On display, too, is the new L&N optical pyrometer which reads directly in degrees of temperature—requires no charts or tables. It employs the potentiometer circuit for high accuracy, is light, easy to operate, and built for uninterrupted plant service. Also demonstrated will be a thermionic amplifier, Universal pH indicator and portable potentiometer.

"Metals and Alloys" New York City

Exhibiting *Metals and Alloys,* "The Magazine of Metallurgical Engineering," which has had a steady increase in paid circulation during the past twelve months. The total monthly net paid circulation now stands at over 7,000 copies. The publishers will also exhibit a number of technical and engineering books of interest to testing engineers.

National Carbon Co., Inc. Cleveland, Ohio

Two new developments will be featured in its exhibit. These consist of the new "National" daylight equivalent lamp for accurate color matching, cotton classing and grading of agricultural and industrial commodities and the new "National" accelerated fading unit for testing color fastness of dyed textiles, paper and similar products. A complete demonstration of these new units will be made along with the latest developments in the unit previously marketed by the company for the accelerated testing of paints, varnishes and lacquers.

Nurnberg Thermometer Co., Inc. Brooklyn, N. Y.

Nurnberg's display and demonstration will consist of a complete line of oil testing instruments for laboratory and field service. This will include A.S.T.M. thermometers; A.P.I. hydrometers; general laboratory temperature and gravity testing instruments; tank car gagers; red reading mercury industrial type thermometers. In particular, featuring new improved products for oil industry service such as Nurnberg's patented tank gagers, Nurnberg's genuine Petroleometer for gravity tests and Nurnberg's Eureka E-Z read laboratory thermometers.

Tinius Olsen Testing Machine Co. Philadelphia, Pa.

Two new testing machines have recently been introduced. One of these is a Universal machine known as Type "L." It is completely hydraulic, very convenient to use due to its low base line, and is in the low price range. It can be bought in capacities ranging from 30,000 to 60,000 lb. The other machine added to the well-known Olsen line is a portable compression machine. It is built in capacities ranging up to 200,000 lb. and weighs but 265 lb. It can easily be transported from job to job in a light truck or passenger car. The machine is designed to break 6 by 12 in. concrete cylinders. A preview of these new machines in the Olsen booth.

Parr Instrument Co. Moline, Ill.

The exhibit of this company will feature their well-known oxygen combustion bombs and an adiabatic calorimeter of the latest type. A complete line of sodium peroxide combustion bombs and accessories will also be shown, including the micro, standard, and recently-developed giant sizes. Other interesting testing devices in this display include a new photoelectric turbidimeter, of simple design, well-suited to many routine laboratory tests, and an improved model of the Dennis melting point apparatus.

E. W. Pike & Co. Elizabeth, N. J.

In this booth will be displayed the Flash-O-Lens, the illuminated magnifier for quick, accurate surface inspections of all materials. Also, this will be the first showing of the entirely new instrument, the Pike-O-Scope, which was developed originally for close internal inspections of valve castings, particularly valve seats. However, this new illuminated instrument has a very wide field of uses.

Radium Chemical Co., Inc. New York City

The Radium Chemical Co., Inc., cordially invites members of the Society to visit their booth. They will have on display radiographs taken with radium, and will also display radium containers as well as handling and shipping containers. Representatives in charge will be pleased to discuss the use of radium for radiography.

Riehle Testing Machine Division, American Machine and Metals, Inc. East Moline, Ill.

Testing machines known the world over since 1825. Riehle will have in operation a 40,000-lb. capacity universal hydraulic testing machine and 110-220 ft.-lb. capacity combination impact tester. Both machines are highly praised by their users to be outstanding in their field. Both have many features which will be demonstrated by actual operation of the machines in the Riehle booth.

Rubicon Co. Philadelphia, Pa.

An extremely interesting exhibit is planned embodying a number of the latest developments in electrical measuring apparatus. Particular interest will center in the Rubicon "Spotlight" galvanometers, sturdy self-contained instruments with exceptionally high sensitivities obtained by internal multiple-reflection optical systems; the type B potentiometer combining high accuracy and wide range with great manipulative convenience; and the Evelyn photoelectric colorimeter so enthusiastically received in prominent laboratories throughout the world.

George Scherr Co., Inc. New York City

In this exhibit will be a new bore inspection telescope for internal inspection of guns, pressure vessels, propeller shafts and steel pipes. Also on display will be the Busch Metaphot, the metallurgical microscope. Particular emphasis will be placed on its adaptability for inspection of assembled and moving units, such as watch movements, in addition to its other metallurgical uses. In these days of super-finished products, the Busch comparison microscope will be a particularly timely exhibit, stressing comparisons of ground, lapped, super-finished, honed, diamond-turned and turned surfaces, with approved master samples.

Henry L. Scott Co., Inc. Providence, R. I.

The keynote of this display will be the light capacity fatigue tester operating on the constant rate of load principle. This machine will be demonstrated by the testing of minute wires, fine textile yarns and similar materials. There will also be exhibited a few of the current models of Scott Testers being generally used throughout the world. Several representatives will be in attendance.

C. J. Tagliabue Manufacturing Co. Brooklyn, N. Y.

An extremely interesting display, including recent developments in oil testing instruments and graphical demonstrations of various operations necessary in making accurate A.S.T.M. etched stem thermometers and hydrometers, can be seen at this booth. The new Celectray indicating controller for creep test furnaces, the new vibration proof indicating controller which is sensitive to temperature but not to vibration, and the Celectray recorder, range 0 to 100 C., will also be shown. These instruments utilize a photoelectric tube, mirror galvanometer, and a beam of light. In addition will be found the TAG-Heppenstall moisture meters for lumber, grain and tobacco.

Carl Zeiss, Inc. New York City

This company will exhibit for the first time the following instruments for technical spectrographic analysis: 1—The new rapid spectrum-line photometer for quick and accurate work. This instrument meets the demands of industrial laboratories which have to submit a large number of analyses daily and therefore require an instrument which allows very rapid determination of line intensities; 2—A small glass spectrograph G1-12 for plates with high light transmission in the near ultra-violet; 3—A three-prism spectrograph with autocollimation camera; and 4—A fully enclosed spark stand for rapid technical spectrum analysis. Besides these new instruments there will be displayed other spectrographic equipment, including a new modified model of the Feussner spark generator, the metallograph NEOPHOT, photometers, refractometers, microscopes and various optical instruments.

Examination of Materials by Microchemical Methods

Editor's Note.—The three papers which follow were presented at the meeting sponsored by the Pittsburgh District Committee in Pittsburgh on November 14 featuring a discussion of the subject, "Examination of Materials by Microchemical Methods." They should be of considerable interest in view of the rapid advancement in industrial applications of microchemistry in the past few years.

Quantitative Organic Microanalysis

By W. R. Kirner[1]

In all fields of human endeavor the principle of economy is of the greatest importance. In leafing through the history of experimental science one constantly encounters descriptions of attempts to improve existing methods, these attempts generally being made with the desire to perform a given task with a smaller expenditure of time, material, or energy, as well as to increase the accuracy, precision, or yield. Since chemistry belongs to a science in which costly materials must often be destroyed in order to learn something about them, the principle of economy involved here is of prime importance. Microchemical methods were developed and have continued to grow because of the economy inherent in them. They have a sound theoretical basis in that chemical phenomena, in general, do not depend upon the absolute amounts of material present but rather upon the relative amounts present.

In order to orient ourselves in a system in which the amount of material used in a given experimental method is the governing factor, we may classify chemical methods according to Table I.

Table I.—Classification of Chemical Methods

Methods	Amount of Material Used		
	Grams or Kilograms	Milligrams	Gammas (γ) = 0.001 mg.
Technical	Kilograms × 10^n	....	....
Semi-technical	Kilograms	....	....
Ordinary laboratory	1 g. to 1 kg.	....	....
Macro (decigram)	0.1 to 1.0 g.	100 to 1000	....
Semi-micro (centigram)	0.01 to 0.1 g.	10 to 100	....
Micro (milligram)	0.001 to 0.01 g.	1 to 10	1000 to 10 000
Ultramicro (gamma)	0.0001 to 0.001 g.	0.1 to 1.0	100 to 1000
		0.01 to 0.1	10 to 100
		0.001 to 0.01	1 to 10

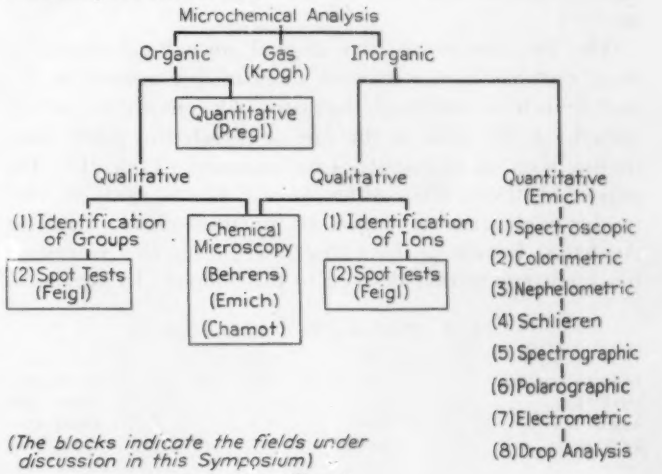
For the purposes of the present paper we shall focus our attention on the micro- and ultramicro methods. Theoretically, one could set up a classification of all of the various branches of chemistry on a micro scale, thus: microinorganic chemistry; microorganic chemistry; microphysical chemistry; microanalytical chemistry; microbiochemistry; etc. In each of these subdivisions, experimental procedures would be carried out on from 0.1 to 10 mg. of material.

The three papers presented here are all concerned with microanalytical chemistry. We can orient ourselves in this field by classification of the subject into various divisions and subdivisions, as shown diagrammatically in Fig. 1.

Many people have the erroneous idea that all microanalyses are performed with a microscope. While the microscope is an important instrument in microanalysis, microscopy is but one of a considerable number of methods which are used in the analysis of microquantities of material. For general purposes we may define microanalysis as consisting of techniques which deal with quantities at least ten times smaller than those used in customary laboratory practice (see Table I). It should be further emphasized that it is the size of the sample that is finally subjected to the analytical process, rather than the amount of starting material used, which determines whether or not one is concerned with a microanalytical procedure.

HISTORY OF THE DEVELOPMENT OF QUANTITATIVE MICROANALYSIS

A new technique for the quantitative handling of micro quantities of material during an analytical procedure was published by Friedrich Emich of the University of Graz, Austria, in 1909. The essential innovation suggested by Emich was the use of really diminutive apparatus, for example, glass capillaries instead of test tubes, glass tubing instead of beakers and flasks, etc., all of the apparatus being on a Lilliputian scale. The use of this small apparatus in connection with correspondingly small amounts of material, gammas instead of grams and cubic millimeters instead of cubic centimeters, demanded the development of a new technique which we may call microtechnique. Emich's success with this technique, applied mainly to inorganic materials, undoubtedly influenced Fritz Pregl, who was, at this time, also at the University of Graz.



(The blocks indicate the fields under discussion in this Symposium)

Fig. 1.

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Friedrich Emich

Fritz Pregl

In the summer of 1910, Pregl was carrying out an investigation on bile. After repeated, tedious operations on 100 kg. of bile, he finally succeeded in isolating 0.4 g. of a new acid. In order to characterize this substance it was necessary to determine its carbon-hydrogen content. At this point Pregl had to decide either to sacrifice a considerable part of his precious compound, with the possibility of having to repeat its tedious preparation in case he ran out of material, or else to develop an analytical method, using previously unheard of small amounts of material, which would yield analytical values leading to the correct empirical formula of his compound. Encouraged by Emich's success in the inorganic field, Pregl chose the second alternative.

By the end of 1911, a period of only a year and a half, he had achieved his goal, for he was then able to determine carbon and hydrogen (in the presence of complicating elements such as nitrogen, sulfur, and halogens) on samples weighing 7 to 13 mg., to determine nitrogen by the Kjeldahl or Dumas methods on samples weighing 4 to 8 mg., and also to determine sulfur and halogens by the Carius method on samples weighing 4 to 8 mg. This meant that his 0.4 g. of bile acid would now suffice for 50 to 60 analyses instead of 3 to 4. In the next few years, Pregl added numerous other determinations to the list, so that by the end of 1913 practically all of the common quantitative organic analyses could be performed with only a few milligrams of material. The development of quantitative organic microanalysis by Pregl is one of the most noteworthy advances in analytical chemistry during the last century. In recognition of this achievement he was awarded the Nobel Prize in chemistry in 1923.

The 25 years which have elapsed since Pregl originated these methods have witnessed a remarkable growth in this new branch of analytical chemistry. One indication of the growth of this field is the rate at which the publications dealing with microchemistry have increased (Table II). The periodical *Mikrochemie-Mikrochimica Acta* is solely devoted to the publication of papers on microchemistry; also, the Analytical Edition of *Industrial and Engineering Chemistry* has a separate section devoted to this subject. In September of this year the Division of Microchemistry of the American Chemical Society was established. Incidentally, this Division has appointed a committee which is cooperating with the Society's Committee E-3 on Chemical Analysis of Metals in looking into the possibilities of having certain microanalytical methods adopted as official A.S.T.M. methods.

Table II.—Published Microchemical Papers.

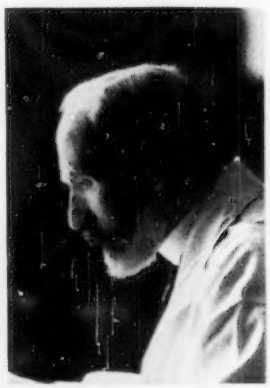
1890-1900	8	1933	1800
1901-1910	17	1934	about 2000
1911-1919	102	1935	about 2250
1920-1924	140	1936	about 2500
1925-1930	440	1937	about 3000
1931	850	1938	about 3600
1932	1500		

MICROCHEMICAL APPARATUS

The most important single item in quantitative microanalysis is the microchemical balance. The main contributor to the development of this balance is Dr. W. H. F. Kuhlmann of Hamburg, Germany. By his master craftsmanship he was, in 1911, the first person who was able to manufacture a balance having a capacity of 20 g. and which weighed accurately to within $\pm$ 0.001 or 0.002 mg. At the present time there are a number of manufacturers from whom microchemical balances having this sensitivity can be purchased. With such a balance a microanalyst can weigh a 2 mg. sample with the same accuracy as a macroanalyst can weigh a 0.2 g. sample on an ordinary analytical balance. Setups of microchemical apparatus used in the determination of carbon-hydrogen, nitrogen, sulfur, halogen and methoxyl, as well as accessory apparatus for filtration, drying, etc., are described and illustrated in the accepted texts on quantitative microanalysis (see bibliography at end of this series of papers).

SAMPLING FOR MICROCHEMICAL ANALYSIS

In dealing with pure homogeneous substances any sample, regardless of size, is directly a true representative of the whole. In such cases sampling presents no problem. This, however, is not the case when one is concerned with heterogeneous materials. Sampling then becomes a serious problem not only for micro- but also for macroanalysis. Many chemists, unfamiliar with microanalytical methods, have a "feeling" that it is impossible to obtain a true representative sample in the very small amount of material (2 to 3 mg.) which is necessary for a microanalysis. However, on theoretical grounds as well as on the basis of experimental facts, it has been demonstrated that if the sample is capable of being finely pulverized or made homogeneous in some other way, for example, by fusion, there is no especial difficulty in getting a representative sample weighing only a few milligrams. For example, if one can get a 10-g. representative sample for macroanalysis from 100 kg. of coal taken from a carload, it should be just as possible to get a 1-mg. representative sample for microanalysis from the above 10-g. sample after it has been finely pulverized.



W. H. F. Kuhlmann

ECONOMIES EFFECTED BY MICROANALYTICAL METHODS

Economy of Materials:

It was the factor of economy of materials that first decided Pregl to attempt the development of organic microanalytical methods. The advantage of micromethods of being able to give correct analytical results on samples weighing only a few milligrams has also been the deciding factor in forcing research workers engaged in problems dealing with expensive rare substances, such as vitamins, hormones, enzymes, etc., isolated from natural sources by difficult, tedious and time-consuming processes, to use these methods. In such cases the use of micromethods is absolutely indispensable. Dr. Doisy, who isolated the female sex hormones, publicly stated in a lecture about two years ago that his discovery of the constitution of these substances would have been impossible if microanalytical methods had not been available. Assuming such material to be worth $5000 per gram, with only 0.2 g. available, a single macro carbon-hydrogen determination would completely destroy material worth $1000 and leave none for further experimentation. A micro carbon-hydrogen determination would destroy $10 worth, leaving 99 per cent of the material for further study.

In the Bell Telephone Laboratories over one-third of the analyses performed in the analytical laboratory are done using micromethods. If micromethods were not available a large part of these analyses could not be made at all, and much-needed information could not be obtained. They have developed microtechniques by means of which many chemical determinations are made, not only leaving the sample undestroyed, but practically untouched!

Micromethods effect proportionate savings in other materials used in the laboratory, namely, gas or electricity, tap and distilled water, and chemical reagents. There is also a very appreciable saving in the cost of apparatus and in the space it occupies. Apparatus for all of the usual organic analyses, including a microbalance, can be purchased for under $1000. The drug firm of Lehn & Fink estimate that they have effected a saving of 50 to 60 per cent in the cost of operating their control laboratory by the installation of a microchemistry laboratory.

Economy of Time:

In industrial or control laboratories, where the amount of material available for analysis presents no problem, the advantages of time economy achieved by micromethods assume prime importance. The reason micromethods are, in general, more rapid than the corresponding macromethods is that it takes less time to complete any reaction involved in an analytical process when one is dealing with only a few milligrams than it does to complete the reaction using quantities from 0.1 to 1.0 g. Generally speaking, micromethods are from two to ten times more rapid than the corresponding macromethods.

Miscellaneous Advantages:

Due to the small amounts of material handled, one can safely carry out microanalyses on extremely explosive materials; analysis of such substances might be very dangerous using ordinary size samples. Also, due to the small size of the equipment, one can freely use platinum, gold, or silver equipment, where such use is desirable but the cost prohibitive on a large scale. The same is true regarding the use of expensive reagents.

ACCURACY AND PRECISION OF MICROMETHODS

There is abundant evidence that the accuracy and precision of micromethods are at least equal to those of the corresponding macromethods. Further, in the course of the development of micromethods, serious, but fortuitous, compensating errors have been discovered in several well-known and constantly used macromethods; when the source of these errors became known through microchemical investigations, it was possible to eliminate them.

THE SCOPE OF APPLICATION OF MICROANALYTICAL METHODS

The numerous advantages of microchemical methods, pointed out above, have now become so apparent that a considerable number of our largest American industries and research organizations have established micro laboratories as an aid to the solution of their problems and in an attempt to reduce costs. A partial list of industries includes: The Abbott Laboratories; Parke, Davis Co.; Merck and Co.; Eli Lilly Co.; United Gas Improvement Co.; Sun Oil Co.; Gulf Research and Development Co.; General Electric Co.; Westinghouse Electric and Manufacturing Co.; Eastman Kodak Co.; American Cyanamid Co.; Bell Telephone Co.; etc. A partial list of research laboratories includes: National Bureau of Standards; Rockefeller Institute for Medical Research; Biochemical Research Foundation; American Medical Association; Boyce Thompson Institute, and the Coal Research Laboratory.

In the ten-year period, 1918-1928, over 300 papers were published on the application of microanalytical methods to the following substances:

Metals and alloys	Products of fermentation industry
Glass and ceramics	Drugs and pharmaceuticals
Paints and varnishes	Cellulose and paper
Mineral fuels	Leather
Foodstuffs	Rubber
Preservatives	Cement
Textiles	

A number of these substances are engineering materials in which the A.S.T.M. has an especial interest. Microanalysis can undoubtedly effect, in this field, the same economies it has already clearly demonstrated it can effect in the field of organic chemistry and related fields.

Qualitative Analysis by Spot Tests

By Gordon H. Stillson[1]

MICROCHEMICAL methods for the quantitative determination of certain inorganic ions, organic radicals, and elements have been used for some time in academic chemical research and are being used more and more extensively in industrial work. With quantitative microanalysis an established and trustworthy technical tool, the investigation of similar methods for qualitative analysis naturally follows.

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The development of a system of microtechnique for chemical work was begun by Prof. Friedrich Emich of the Technische Hochschule, Graz, Austria, in 1900 and was essentially completed in 1911 with his "Lehrbuch der Mikrochemie" (Bergmann, 1911). Emich's "Lehrbuch" is still the basic text in qualitative microanalysis. Later one of Emich's students, A. A. Benedetti-Pichler of New York University, set forth refinements and additions to the work of Emich.[2]

In 1918, Prof. Fritz Feigl at the University of Vienna started his work on spot methods of qualitative analysis, culminating twelve years later (1930) in the publication of his book describing the new technique.[3] In 1935 the second edition of Feigl's book was presented and in 1938 the third edition left the press. The experimental section of the second edition was translated into English in 1937.[4]

It is the purpose of this paper to describe and comment upon Feigl's spot-test technique for the identification of materials. While in many instances the procedures of Emich and Benedetti-Pichler require the use of a microscope, the Feigl tests need only relatively simple apparatus, much of which can be constructed by the analyst. The term "spot test" is derived from the procedure by which a crystal or drop of an unknown material, or a drop of its solution, is placed on a piece of filter paper which has been impregnated previously with a certain reagent. Conclusions as to the nature of the unknown material are then drawn from the color or character of the spot produced upon the test paper. A spot test well known to all chemists is the litmus paper test for hydrogen ion or hydroxyl ion.

The primary advantage of spot tests is their ability to bring about identification where only minute amounts of material are available. In most cases only 0.5 ml. or a few milligrams of sample are needed for the identification of substances, even though a number of tests are necessary. Rivaling small sample size as an advantage is the speed and accuracy with which spot tests may be run. Many of the reactions may be performed as rapidly as the litmus paper test. Economy of time in making qualitative analyses is particularly advantageous where a sample has been submitted for quantitative analysis. Much of the analyst's time may be saved if he can find out, quickly and with certainty, which groups or ions must be determined quantitatively, and which groups or ions will introduce complications into his quantitative analysis. Because of the great sensitivity of most of the spot tests, mere traces of material are easily detected. Sensitivities and concentration limits will be discussed later.

Laboratory space is a problem in most industrial and academic laboratories. The chemist usually hesitates to adopt a new procedure which will require a special room or a considerable portion of an established laboratory room. Spot tests can be performed on about four square feet of desk surface and the necessary apparatus and reagents can be stored in a small cabinet or a couple of average-size drawers (Fig. 1).

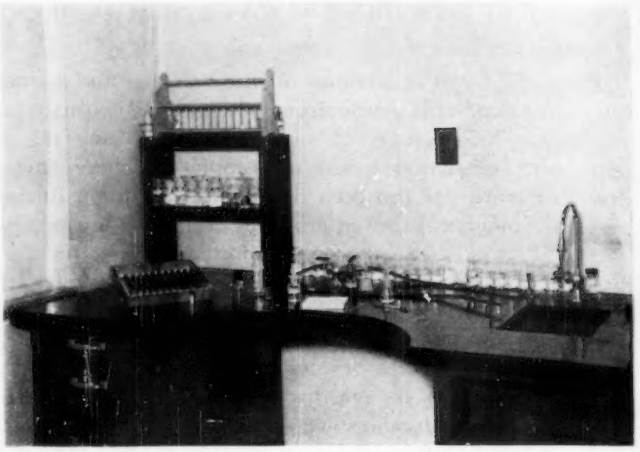

FIG. 1.—Microscope Table Used for Spot-Tests in the Micro-Laboratory of the Gulf Research and Development Co.
The small vials in the box at the left contain most of the solid reagents used in spot-testing.

It is difficult to find any real disadvantages for spot tests. Interfering ions are not so serious a problem as they are in macroanalysis. Several alternative tests are generally available, and the separation of colors and precipitates due to varying rates of diffusion through the spot paper affords a means of circumventing complications due to interfering substances. In some cases the very high sensitivity of the tests can become a disadvantage, since positive tests may be obtained for many components in a sample, without their being present in large enough amounts to be determined quantitatively. Therefore, the analyst must use discretion in reporting the presence of these ions or groups until he has shown them, by dilution tests, to be present in significant amounts.

Professor Feigl's book describes spot tests for practically all of the metallic ions, as well as the commonly occurring anions. Tests are given for detecting the more important classes of organic compounds, and in many cases the specific compounds can be identified. In addition, special reactions are mentioned such as the detection of beryllium, uranium, or titanium in minerals, the investigation of leather to determine the method of tanning, group reactions for organic dyestuffs, the differentiation between plant and animal fibers, and many others. In short, there are few analytical problems to which spot tests cannot be applied.

Because of the small volumes and masses involved in the use of spot methods of analysis, only very sensitive tests are, in general, applicable. Feigl expresses the sensitivities of tests by means of two values: the *limit of identification*, which is defined as the smallest weight of a substance per macro-drop (0.05 ml.) of its solution which always gives a positive test for the substance; and the *concentration limit*, the ratio of one unit weight of material to the maximum number of unit weights of solvent in which one unit weight of the material always gives a positive test. The unit of weight used is the *gamma* (γ) which is equal to a millionth of a gram (0.001 mg.). The high sensitivities involved in some of the spot tests can be illustrated by referring to specific examples. The following sensitivities were determined in the micro laboratory of the Gulf Research and Development Co.

[2] Benedetti, Pichler and Spikes, "Introduction to the Microtechnique of Inorganic Qualitative Analysis," Microchemical Service, Douglaston, N. Y. (1935).
[3] Fritz Feigl, "Qualitative Analyse mit Hilfe von Tüpfelreaktionen," Leipzig (1930).
[4] Fritz Feigl and Janet Matthews, "Qualitative Analysis by Spot Tests," Nordemann Publishing Co., New York City (1937).

Tested for	Limit of Identification, gammas per 0.05-ml. drop
Lead (Pb^{++}) in presence of 10 times the amount of Ag^{+}, Cu^{++}, Cd^{++}	3.0
Copper (Cu^{++})	0.03
Nickel (Ni^{++}) in presence of 1000 times the amount of Fe^{+++}	2.5
Nickel (Ni^{++}) in presence of 600 times the amount of Cu^{++}	8.5
Iron (Fe^{+++})	0.15
Phosphate (PO_4^{---})	0.25 (as P_2O_5)
Organic halogen	0.25 to 0.50
Phenols	2.0 to 5.0
Aldehydes	1.0 to 1000
Diphenylamine	6.25
Glycerol	5.0

It will be noticed that in some cases the sensitivities are given in the presence of complicating ions; also that the tests for organic radicals and compounds are considerably less sensitive than those for the inorganic ions.

Many of the spot tests are not specific for certain ions or groups. In such cases alternative tests can be chosen or interfering substances can be removed beforehand, or may be identified or eliminated by their specific reactions. A separation may be carried out on as little as a drop of a solution or mixture, since precipitation, filtration, and distillation of such small amounts of material are all possible and are described in detail in Feigl's text. Due to capillary attraction in the test paper, it is sometimes possible to obtain specific tests for a substance where the same reaction in a test tube would show nothing.

Some of the reagents needed for spot testing are available through ordinary sources of reagent chemicals. Most of the less common ones are now specially prepared and packaged for spot testing by the Eastman Kodak Co. of Rochester, N. Y. and are not particularly expensive. Very small amounts last a long time and the more expensive ones are put up in 1-, 5-, and 10-g. containers. For the most part, they are stable and may be kept for long periods, under favorable conditions, without losing their effectiveness. Feigl calls attention to those reagent solutions which must be made up fresh before being used in a test. Where there is any doubt as to the purity or condition of a reagent, the analyst must carry out a blank analysis to guard against contamination or deterioration.

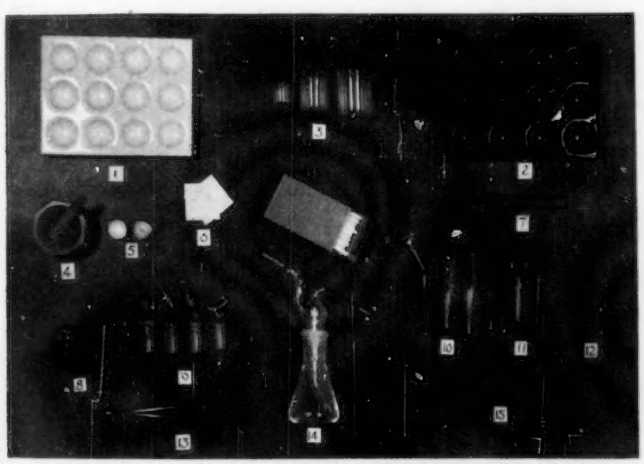

FIG. 2.—Typical Pieces of Apparatus.

1 and 2. White and black porcelain test plates.
3. Micro-beakers, 1, 3, and 10 ml.
4. Agate mortar and pestle.
5. Porcelain crucibles, 0.5 ml.
6. Spot test papers.
7. Micro-pipettes.
8. Jewelers' loupe, 4-7X.
9. Vessels for testing evolved gases.
10. Centrifuge tubes and filter.
11. Micro-funnels.
12. Capillary for fusions; (13) Forceps; (14) Wash-bottle, 20 ml.
15. Glass capillaries for transfer of liquids and for stirring rods.
The box of safety matches is included to show comparative size of apparatus.

The paper used for conducting spot tests may be any high-grade filter paper on which a drop of liquid or solution will not diffuse too readily. However, the values for the sensitivities of tests, as reported in Feigl's book and in this paper, apply to a special spot paper (No. 601) manufactured by Schleicher and Schüll; when a paper is used in which the diffusion rate is different, new values must be obtained. When phosphate or iron are to be tested for, Schleicher and Schüll "Blue Band" filter paper No. 589 must be used since the No. 601 contains these ions.

The cost of a complete outfit for carrying out spot tests, exclusive of the reagents, should not exceed $35. This would include the following list of articles:

2	Spot plates, white
1	Spot plate, black
1 doz.	White porcelain crucibles, 0.5 to 1.0 ml. capacity
½ doz.	Pyrex beakers, 5 ml. capacity
½ doz.	Pyrex beakers, 10 ml. capacity
3 doz.	Pyrex test tubes, 10 mm. by 75 mm.
1 doz.	Watch glasses, 25 mm. diameter
1	Small platinum foil (for ashing)
1	Pair small straight forceps
1	Jeweler's glass, 4 to 6 power
1	Adjustable microburner
1	Glass-stoppered test tube, 2 ml. capacity
1	Micro-ignition tube
3	Gas evolution vessels (described by Feigl and obtainable through microchemical supply houses)
6	Funnels, 60 deg., constricted stem, 25 mm. diameter
1	Metal heating block and thermometer
2	Small wash bottles, 20 ml. to 50 ml. capacity
100	Sheets Schleicher and Schüll Spot Paper No. 601, 14 by 22 cm.
100	Sheets Schleicher and Schüll "Blue Band" Filter Paper No. 589, 9 cm. diameter

A few typical pieces of apparatus are shown in Fig. 2.

The above equipment is available through the scientific and microchemical supply houses. The list does not include glass apparatus such as micropipettes and capillaries which can be constructed easily by the analyst himself. A small hand or power centrifuge greatly facilitates some of the tests and can be purchased at a cost not exceeding fifteen dollars. Feigl's book, needless to say, is a necessary part of a spot-testing outfit.

In order to illustrate the technique of spot testing clearly, the following typical tests will be described in detail:

Test for Copper with Rubeanic Acid:

A drop of approximately neutral test solution is placed on a piece of spot paper previously impregnated with a 0.5 per cent alcoholic solution of rubeanic acid, $(CS)_2(NH_2)_2$, and held in the fumes from an ammonia bottle. A black fleck or circle indicates copper. Since the test is sensitive to slight traces of copper in distilled water, a blank test must be run on the distilled water used. In the presence of high concentrations of ammonium salts, the test loses some of its sensitivity.

Limit of identification: 0.03γ copper per 0.05 ml.
Concentration limit: 1:2,500,000

Since cobalt and nickel give brown and blue rubeanates, respectively, the test must be modified if one or both of these are present. A drop of the test solution is acidified with acetic acid before being placed on the filter paper impregnated with rubeanic acid. If cobalt is present the black central spot is surrounded by a yellow-brown ring of cobalt rubeanate. If nickel is present the central zone is encircled by a ring of blue-violet. If both interfering ions are present, the copper can still be identified by the color of the central region. The sensitivity of the test is reduced somewhat by the presence of cobalt and nickel.

Simultaneous Detection of Copper, Mercury, Lead, and Bismuth:

A solution of cinchonine and potassium iodide with certain metallic ions, causes the precipitation of insoluble (and in some cases colored) double iodide complexes of the metals. This property of the reagent can be utilized in simultaneously demonstrating the presence of copper, mercury, lead, and bismuth. When a drop of solution containing these metal ions is placed on a spot paper impregnated with the reagent, the following zones can be perceived:

1. A white central ring, containing complex double iodide of mercury.
2. An orange-colored ring, containing complex double iodide of bismuth.
3. A yellow ring of lead iodide.
4. A brown ring of iodine, caused by the oxidation of iodide ion by cupric ion.

Detection of Chromium:

Chromium salts may be oxidized easily to chromates with sodium peroxide. Chromates in turn oxidize benzidine to a blue quinoid compound.

Sodium peroxide solution, freshly prepared, is placed on a test paper with a drop of the suspected chromium solution. The resulting chromate diffuses to the edge of the moist spot. It is then treated with an acetic acid solution of benzidine. Chromium is indicated by the formation of a blue ring (benzidine blue).

Limit of identification: 0.25γ chromium per 0.05 ml. drop
Concentration limit: 1:200,000

Vanadates and the higher oxides of manganese interfere with the above test; an alternative test eliminates these complications.

Detection of Nitrate Ion:

In the absence of other oxidizing agents, the nitrate ion oxidizes diphenylamine to a deep blue compound. In this test for nitrate, a white porcelain spot plate with a number of cup-shaped depressions is used instead of the customary spot paper. A few crystals of diphenylamine are treated with sulfuric acid, diluted with a little water, and placed on the plate. A drop of the test solution is placed in the center of the acidified amine solution. In the presence of nitrate ion a deep blue ring forms where the liquids mix.

Limit of identification: 0.5γ nitric acid per 0.05 ml. drop
Concentration limit: 1:100,000

Incidentally, this test may also be used as a specific reaction for diphenylamine.

Electrographic Detection of Nickel:

Through the use of a dry cell, a pair of simple aluminum electrodes, and a solution of dimethylglyoxime, extremely small amounts of nickel can be detected in metallic objects without defacing them (Fig. 3). The article to be tested is connected to the positive pole of the dry cell. A piece of spot paper moistened with a 1 per cent alcoholic solution of dimethylglyoxime is pressed into contact with the unknown metal, and a paper moistened with a solution of a neutral electrolyte, such as sodium sulfate, is, in turn, pressed against the paper containing the oxime. The cathode, or negative pole, completes this electrolytic "sandwich," and enough pressure is applied to the whole so that intimate contact is obtained throughout. After the current has been passed for about five minutes, a red precipitate of the nickel salt of dimethylglyoxime will form on the reagent paper if nickel is present in the sample. The current causes the metallic nickel, as the anode, to ionize and react with the reagent. As little nickel as is present on silver coins through contact with five-cent pieces in the pocket can be detected by this method. The procedure is altered slightly if iron or cobalt are present.

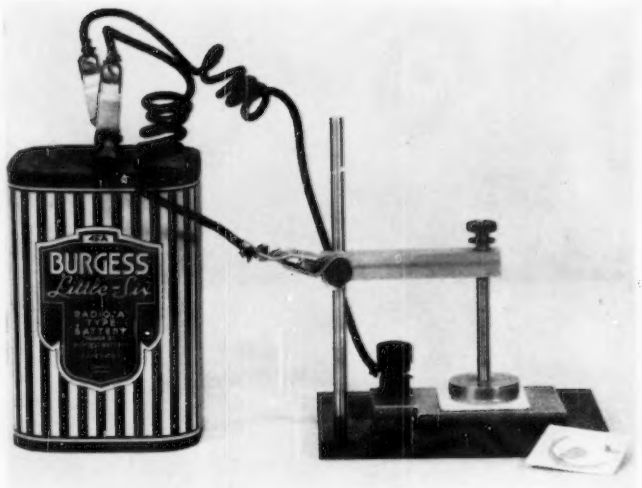

FIG. 3.—Apparatus for the Electrographic Examination of Metallic Samples.

Detection of a Phenol:

An aqueous or alcoholic solution of a phenolic compound, when treated with a drop of 2 per cent aqueous solution of phosphomolybdic acid, followed by one drop of concentrated ammonium hydroxide, produces a rich blue color.

Limit of identification: 2.0 to 5.0γ per 0.05 ml. drop
Concentration limit: 1:5000

Spot tests, when once used, become indispensable. Complex commercial mixtures frequently can be identified sufficiently without resorting to any of the usual methods of separation and isolation. Many tests can be made on a material without even putting it into solution. If purification is necessary, the micro methods require little material and can be performed in a fraction of the time necessary for the conventional procedures. In addition, the rather high sensitivity inherent in the tests makes them applicable where test tube reactions fail.

In petroleum research we have found the spot test technique most valuable. This can be illustrated by actual examples. Recently an unusual deposit appeared on the valve of a gasoline test engine. It was important that the cause of this deposit be determined. The valve was submitted to the

microchemical laboratory, where the deposit was carefully removed. The sample to be analyzed amounted to about one milligram. It was extracted with acetone to separate and isolate any organic material, and the residue from evaporation of the extract was found to ash completely, indicating the presence of organic matter. The acetone-insoluble portion of the sample was then tested for eight components which conceivably could have been present. Tests for calcium, silver, and lead were negative, indicating that water, which almost invariably contains calcium compounds, had not seeped into the crankcase oil, that the deposit was not due to the presence in the oil of silver soaps from the cadmium-silver connecting rod bearings, and that the deposit did not come from the decomposition of lead tetraethyl used as an antiknock in the gasoline. Positive tests were found for copper, aluminum, iron, sulfate, and organic sulfur. The copper was traced to a copper tube in the gasoline line, the aluminum came from the aluminum piston and cylinder head, the iron from corrosion of the valve itself, and the sulfate from the combustion of organic and elemental sulfur present in the gasoline. The organic sulfur was undoubtedly due to unburned organic polysulfides left in the gasoline after the sweetening process.

Addition agents are frequently added to petroleum products to inhibit gum formation, oxidation, or corrosion, or to change some property of the material. Since these additions are usually made in amounts of the order of a fraction of a per cent, only microanalytical methods can be used in detecting them. In attempting to develop such addition agents it is helpful to know the nature of the deterioration products which make the addition necessary. Here, too, the spot tests are useful as a means of identification.

In addition to the value of qualitative microanalysis in regular lines of research, it becomes important in the sales type of research. Complaints involving precipitates, deposits, colorations, odors, or tastes, are closer to speedy and efficient adjustment if rapid, sensitive spot tests are available. Raw materials are often the cause of trouble, and their purity can be determined quickly and accurately by these methods.

In connection with the quantitative A.S.T.M. chemical tests, there are innumerable applications for spot tests. In most cases the analyst can determine by spot tests, in the time it would take to make a couple of weighings, the qualitative composition of a sample to be analyzed quantitatively. Thus he quickly confirms the presence of the constituents he is to determine, and at the same time may detect substances which might influence the results of a quantitative determination.

There are certainly innumerable applications for spot tests in industrial research and testing which have not been mentioned here. The knowledge and use of the technique brings out far-reaching advantages and applications. Emich himself referred to spot tests as "the qualitative analysis of the future." It is hoped that they will soon find their place among the established analytical procedures.

Microscopy in Industrial Research and Control Work

By E. B. Ashcraft[1]

DURING the past summer, Lord Rayleigh in his presidential address[2] before the British Association for the Advancement of Science made the following statement: "The use of lenses is one of the greatest scientific discoveries . . . ." In times like these when fine optical instruments are comparatively common and when the scientific literature is full of new and exciting terms—artificial radioactivity, crystallizable viruses, electron diffraction, hormones, neutrons, cooperative phenomena—a statement like this is apt to sound somewhat surprising. This is almost unquestionably due to the fact that the period of most rapid discovery in optical science is past—the exciting new ideas and facts of yesterday are actually in use today and so have become commonplace. It is unwise to make dogmatic statements concerning the future; the first part of the above sentence may be proved false next week, particularly if we take the more general view that lenses are not necessarily material things, but may be fashioned out of electric and magnetic fields.

What has been said concerning optical science in general is true also of the particular field, microscopy. It is the purpose of this paper to present a survey of the kinds of problems which are being attacked and the kinds of information which can be gained by the use of the microscope and its accessories. The characteristics of the instruments themselves which are fundamental to all applications are included; for the rest, those fields of application which in the author's opinion are least familiar, have been more fully treated than others. The smallness of the sample required for microscopic observation has not been stressed unduly. In many applications it is not the limitation in the amount of sample available which makes the use of the microscope desirable, but rather considerations as to speed and type of information to be obtained.

We may conveniently consider the microscope in two capacities: as an instrument for making visible those things which are too small to be visible to the unaided eye, and as an instrument for determining the optical properties of materials. Its uses in both capacities are widespread and naturally there is much overlapping.

The first question which arises in connection with the use of the microscope is often, "How small an object can be seen with it?" The question put in this manner defies a direct answer. If by "seeing" is meant merely the ability to detect the presence of very small particles without regard to their size and shape, then the lower limit is very small indeed. Such observations are made with the ultramicroscope, an instrument which differs from any high-power microscope only in the method of illuminating the object. This is done by means of rays coming from such an angle that they cannot enter the objective directly. Small particles in the path

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[1] Research Engineer, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

[2] Lord Rayleigh, "Vision in Nature and Vision Aided by Science," *Nature*, Vol. 142, p. 329 (1938).

of these rays will scatter some of the light so that it enters the objective and the particles will be seen as tiny, luminous points on a black field. The ability to see such points is limited only by the intensity of the scattered light and its contrast with the field. This in turn depends on a number of factors, but in general particles down to about two millionths of a millimeter (one thirteen-millionth of an inch) can be observed.

Returning now to the original question, if by "seeing" is meant the ability to distinguish size, shape, and structural details, the problem is still more complicated. The question may now be restated thus: "What is the smallest separation of two points on the object which may be seen as two points in the final image?" This is not the place to attempt a rigorous solution of this problem; indeed, no truly satisfactory solution has as yet been given. Treatments similar to original ones given by Abbe, von Helmholtz and Lord Rayleigh[3, 4] show that this distance, S, is given by the formula

$$S = \frac{1.22\,\lambda}{2n \sin \alpha} \qquad (1)$$

where λ = the wave length of light used,
n = the refractive index of the medium of lowest index between object and objective, and
α = one half of the angle subtended at the object by the objective.

This formula is derived for the case where the points are considered as independent, self-luminous sources; if, instead, the light from the two is in phase, the resulting distance of separation is just twice as great. Experiments have shown that for many objects, Eq. 1 is very nearly correct.

A closer examination of Eq. 1 reveals several interesting facts. It is immediately apparent how the resolving power, S, depends on the wave length of light used and on the refractive index of the medium between the object and the lens. Values obtained for S in some typical cases are given in Table I. A word should be said concerning the "useful magnification" also tabulated here. There is no limit to the number of times the image from the objective may be magnified, but such magnification adds nothing to the resolution which is determined by the factors given above. Consequently, magnification beyond the point where details of the image can be easily resolved by the eye is useless.

It should be borne in mind that Eq. 1 was derived for the case where the object is illuminated with a light beam of sufficiently wide angle to completely fill the aperture of the objective. Furthermore, the most perfectly corrected lenses were assumed. Actually these conditions can be met in practice. But a third assumption, that of sufficient contrast between the object and its surrounding medium, is hard to realize in many preparations. Because of the increased selectiveness of absorption of ultraviolet light, the "ultraviolet" microscope largely overcomes this lack of contrast. The great usefulness of this instrument in high-power microscopy is due almost as much to this fact as to its greater resolving power.[5]

Table I.—Resolution[a] and Useful Magnification[b] in Typical Cases.

Wave Length of Light Used, λ	Instrument Designation	Numerical Aperature, $n \sin \alpha$	Resolving Power, S	Useful Magnification
5000 Å	Oil immersion	1.4	0.23×10^{-3} mm.	X 1400
2750 Å	Ultraviolet	1.4	0.12×10^{-3} mm.	X 2500
5000 Å	Mono-brom-naphthalein immersion	1.65	0.19×10^{-3} mm.	X 1600
5000 Å	Dry	0.95	0.32×10^{-3} mm.	X 900

[a] Based on formula $S = \frac{1.22\,\lambda}{2\,n \sin \alpha}$

[b] Useful Magnification is taken as that magnification which enlarges S to twice the distance which can be resolved by the average eye.

Recently stress has been laid on improvements in the mechanical system of the microscope.[5, 6] Graton and Dane[6] claim that by increasing the general mechanical stability and precision of focusing and by using suitable objects, they have resolved distances of less than 0.10 μ with ordinary oil-immersion objectives and visible light. Consequently, they suggest that the theory of resolving power, at least in its application to the microscopy of opaque objects, may be in need of revision.

When the microscope is equipped with a polarizing prism, rotating stage, compensators, analyzer, and Bertrand lens, it becomes a most useful tool for the determination of optical properties. These will be considered later.

Before taking up some of the interesting applications, a few words should be said, by way of orientation, concerning the role of microscopy at the Westinghouse Research Laboratories. Figure I shows a unit equipped for general microscopy. We have here within easy reach of the operator, apparatus for all sorts of microscopic investigations: a binocular microscope for low-power work, a dental drill for sampling hard materials, a centrifuge, reagent blocks, a chemical microscope with hot stage accessories, a micromanipulator, a microscope for observation by reflected light, a petrographic microscope for precision optical determinations, and many accessories. This unit is a portion of a laboratory devoted to special analytical investigations which include, besides microscopy, quantitative microchemical methods, spot testing, and spectrographic methods.

Most applications of the microscope are based both on its ability to resolve and magnify and on its ability to de-

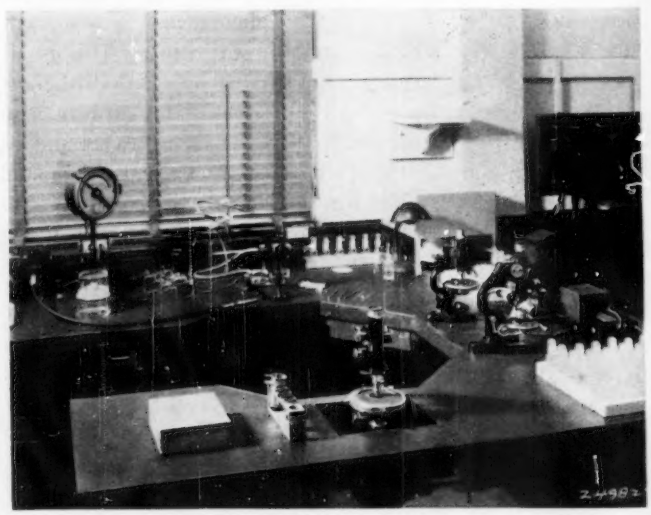

FIG. 1.—Microscopic Equipment in Micro-Analytical Laboratory, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

[3] C. F. Meyer, "The Diffraction of Light, X-rays and Material Particles," University of Chicago Press (1934).
[4] Max Born, "Optik," Julius Springer, Berlin (1933).
[5] F. F. Lucas, "Late Developments in Microscopy," *Journal*, Franklin Inst., Vol. 217, p. 661 (1934).
[6] L. C. Graton and E. B. Dane, Jr., "A Precision, All-Purpose Microcamera," *Journal*, Optical Soc. America, Vol. 27, p. 355 (1937).

termine optical properties. Examples of fields where the former ability is the predominant characteristic are metallography, bacteriology, and the classical techniques of the biological sciences. Another important field is that of the determination of particle-size distributions. Such determinations are necessary in dealing with materials such as pigments, fillers, abrasives, ceramic materials, ores, and many others. Recently important applications to the study of industrial dusts and air pollution have arisen. Figure 2 shows photomicrographs taken in connection with such a study. These illustrate the differences in the size of particles to be found in air which has been cleaned by different methods. When the cleaning was done by an electrostatic air cleaner (the Westinghouse Precipitron)[7] no particles larger than about 0.7 μ (0.0003 in.) were found (Fig. 2(*a*)). When the cleaning was done by a common, commercial, oil-coated filter at the same flow and pressure drop, many particles ranging in size from 2 to 5 μ and several as large as 10 μ (0.0004 in.) were found (Fig. 2(*b*)).

An application of particular interest to the microchemist is that of micrurgy—the technique of manipulating small amounts of materials. Such a technique is often necessary, particularly in obtaining a proper sample. The microchemist does not often receive a sample nicely prepared and ready for analysis. It is usually in the form of a speck, inclusion, or small region which must be carefully separated from adjacent material. The operation must be all the more delicate because of the sensitivity of the tests to be used later. The methods used vary from relatively crude methods using dissecting needles and dental drills to those involving the micromanipulator, a mechanical device making possible movements so fine and so precise as to permit the dissection of single cells in biological material. With the help of this instrument, specks too small to be seen with the naked eye have been treated with reagents and satisfactorily analyzed.[8] Figure 3 is a comparison of a micro tool with the point of a sewing needle.

The methods of microscopic qualitative analysis are unquestionably the oldest of those procedures which are now classed under the general heading of microanalysis. They were well established nearly fifty years ago,[9] but for many years chemists were singularly backward in taking advantage of them.

[7] G. W. Penny, "A New Electrostatic Precipitator," *Electrical Engineering*, Vol. 56, p. 159 (1937).

[8] R. N. Titus and H. Le B. Gray, "Chemical Micrurgy," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 2, p. 368 (1930).

[9] E. M. Chamot and C. W. Mason, "Chemical Microscopy II. Its Value in the Training of Chemists," *Journal of Chemical Education*, Vol. 5, p. 262 (1928).

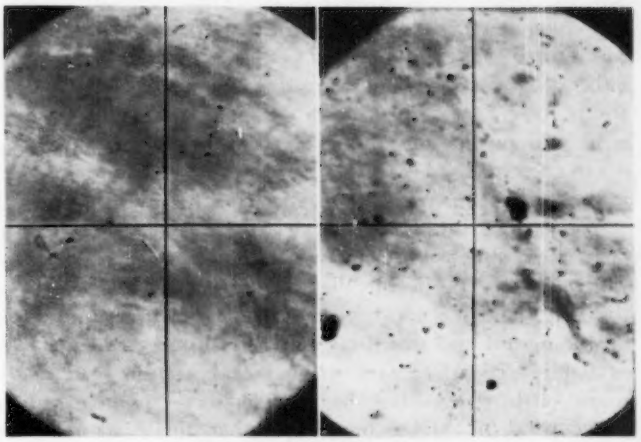

FIG. 2.—Dirt Particles in Air.
(original magnification — × 1000, reduced one half in reproduction).
(*a*) Cleaned by Westinghouse precipitation.
(*b*) Cleaned by mechanical filter.

At this point it is important to emphasize the use of the polarizing microscope for the determination of structural and optical properties. Table II is a list of these properties applicable to transparent, crystalline substances. This table also shows whether these properties may be used for distinguishing between different crystal classes or between individual substances within a class. Enclosure within brackets indicates distinctions between classes; within parentheses, between individuals. It should be pointed out that not all of these properties are independent. However, every property listed does correspond to a different experimental mea-

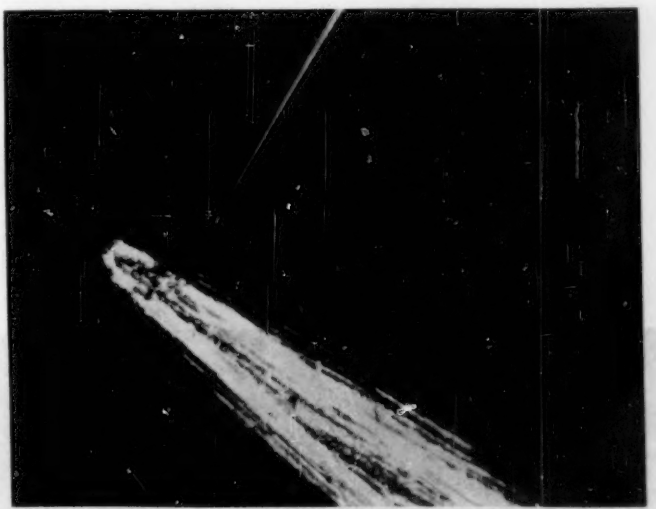

FIG. 3.—Glass Probe of Micro-Manipulator Compared with Point of Fine Sewing Needle (X 150).

Table II.—Optical and Structural Properties of Transparent Crystalline Substances.

1. Isotropic-anistropic	[Cubic]	[Tetragonal	Hexagonal	Orthorhombic	Monoclinic	Triclinic]
2. Refractive index, ω	(Cubic)	(Tetragonal)	(Hexagonal)			
3. Refractive index, ε		(Tetragonal)	(Hexagonal)			
4. Refractive index, α				(Orthorhombic)	(Monoclinic)	(Triclinic)
5. Refractive index, β				(Orthorhombic)	(Monoclinic)	(Triclinic)
6. Refractive index, γ				(Orthorhombic)	(Monoclinic)	(Triclinic)
7. Dispersion of indices	(Cubic)	(Tetragonal)	(Hexagonal)	(Orthorhombic)	(Monoclinic)	(Triclinic)
8. Habit	(Cubic)	(Tetragonal)	(Hexagonal)	(Orthorhombic)	(Monoclinic)	(Triclinic)
9. Color	(Cubic)	(Tetragonal)	(Hexagonal)	(Orthorhombic)	(Monoclinic)	(Triclinic)
10. Rotation of plane of polarized light	(Cubic)	(Tetragonal)	(Hexagonal)	(Orthorhombic)	(Monoclinic)	(Triclinic)
11. Uniaxial-biaxial		[Tetragonal	Hexagonal]	[Orthorhombic	(Monoclinic)	Triclinic]
12. Optic sign		(Tetragonal)	(Hexagonal)	(Orthorhombic)	(Monoclinic)	(Triclinic)
13. Pleochroism		(Tetragonal)	(Hexagonal)	(Orthorhombic)	(Monoclinic)	(Triclinic)
14. Symmetry		[Tetragonal]	[Hexagonal]	[Orthorhombic]	[Monoclinic]	[Triclinic]
15. Angle of optic axes				(Orthorhombic)	(Monoclinic)	(Triclinic)
16. Dispersion of optic axes				(Orthorhombic)	(Monoclinic)	(Triclinic)
17. Dispersion of bisectrices					(Monoclinic)	(Triclinic)
18. Angles of principal axes					(Monoclinic)	(Triclinic)

Note.—Enclosure within brackets indicates distinctions between classes; within parentheses, between individuals.

surement. And all of these measurements are made without any chemical transposition of the material. The value of this fact in determining the particular compound present rather than just the ions is readily apparent. Indeed, this ability to study a solid material "as it is" rather than "as it is in solution" is one of the outstanding advantages of the microscopic method.

It is, of course, evident that practically any of the usual reactions of qualitative analysis can be carried out in a drop on a micro slide. But a far wider choice of reagents is possible since, in addition to the sole criteria of the macro test, the appearance or non-appearance of a precipitate or color, all the optical and structural properties listed above are now available. It can be said without exaggeration that microscopic qualitative analysis has a wider scope, is more certain and dependable, and is more rapid than the usual macro or test-tube methods.

In passing, the availability of accessories for measuring other physical properties such as hardness and melting point on tiny single crystals should be noted. The latter property is particularly significant in organic analysis.

A general idea of the method of carrying out a test may be gained by following in outline the procedure used in the case of a particular problem. In a certain installation, commutation trouble was being experienced and it was suspected that a film of some kind on the commutator was responsible. Samples were obtained by scraping the surface with the sharp edge of a clean glass slide. These scrapings consisted mostly of carbon dust from the brushes and copper, along with any film which might have been present. The material in a little pile on a micro slide was wetted with a drop of water and a crystal of calcium chloride added. This drop was then exposed to bromine vapors by inverting it over a bottle of bromine. After a minute or so, the slide was removed and the drop examined under the polarizing microscope. The carbon particles were unchanged and the copper had gone into solution as the bromide. Numerous sheaves of needle-like crystals were found around the edges of the preparation and under higher magnification these were positively identified by the angle at which their ends were truncated and by their oblique extinction in polarized light, as crystals of calcium sulfate dihydrate, $CaSO_4 \cdot 2H_2O$. This proved beyond a doubt the presence of a copper sulfide film on the commutator. The sulfide in the sample had been oxidized by the bromine to sulfate which had formed characteristic crystals with the calcium. The procedure was carried out in less than half an hour and no separation of the copper and carbon dust which were predominant in the sample was necessary.

Another type of problem quickly solved by use of the microscope was the following: A question had arisen as to the source of some tiny globules of copper found on the face of a brush in an experimental setup. These might have come either from the brush itself which contained copper powder, or from the commutator ring. In this case it was possible to distinguish between the two sources by a qualitative analysis, necessarily micro in scale, because of the size of the sample. The ring was made of an alloy containing a few per cent of chromium and a microscopic test for this element quickly showed that material from the ring was present in the globules.

The study of phase equilibria is a field to which the application of microscopy has proved pre-eminently useful. The direct observation of the phase changes in solids which take place with change of temperature and of the phenomena of one crystal form which dissolves in a solution as another form separates is of real value to the investigator of such systems in understanding them. Determinations of the equilibria existing at high temperatures in refractory materials could hardly have been made without the technique of rapid quenching and examination with the polarizing microscope. The useful applications to metallography are fully appreciated by most technical men.

Figure 4 illustrates an application to an aqueous system. In many such systems, the solid phases present can be determined only with difficulty or not at all by the usual methods of analysis. In the present example, it is estimated[10] that the work was carried out in at most a third of the time which would have been necessary had ordinary methods of analysis been used. The solid phases shown are those in

[10] C. W. Mason and E. B. Ashcraft, "Tri Sodium Phosphate—Sodium Fluoride, Analytical Methods and Phase Studies," *Industrial and Engineering Chemistry* (in press).

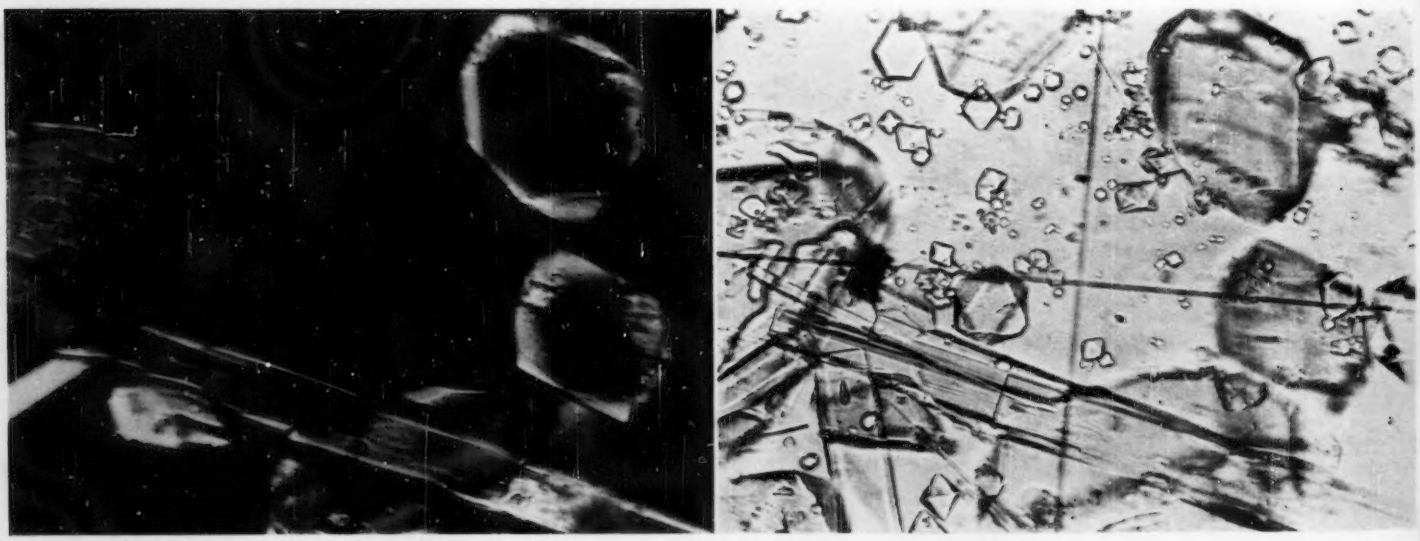

FIG. 4.—Three Solid Phases of the System Sodium Fluoride—Sodium Phosphate—Phosphoric Acid—Water (X 150).

(*a*) Viewed by ordinary light. (*b*) Viewed by polarized light.

equilibrium with one of the solutions in the system sodium fluoride—sodium phosphate—phosphoric acid—water. The three solid phases are easily distinguished. The octahedral crystals, a double salt of sodium fluoride and trisodium phosphate are recognized both by their shape and by their behavior in polarized light, Fig. 4(*b*). The two remaining forms, trisodium phosphate and disodium phosphate, may be distinguished by their shapes or by the observation of their interference figures. Further observation reveals the fact that the corners of the large tabular crystals, disodium phosphate, are beginning to round off. This means that as the temperature is raised (room temperature was slightly higher than the temperature at which the crystallization took place) this phase goes into solution more rapidly than the others.

Quantitative as well as qualitative analyses are often carried out microscopically and are used as routine control tests in many industries. Such tests are usually based on one of the following procedures: estimation either from memory or by comparison with standards; the counting of one or several constituents; the measurement of areal or linear intercepts. In systems which form solid solutions it is possible to make quantitative analyses by determining suitable optical properties as functions of composition. An example is the recent work of Bryant on the analysis of mixtures of acetic and propionic para-bromoanilides.[11]

A type of analysis based on a somewhat different property from those previously mentioned is fluorescent analysis. The use of this technique requires a system for illuminating the sample with ultraviolet light. The fluorescence excited is observed with an ordinary microscope. This method has proved especially successful in the identification of organic materials. It holds much promise for the investigation of such processes as impregnation, wetting and emulsification.[12]

It would be possible to give many more interesting and important examples of the applications of microscopy. Two promising fields which should perhaps be mentioned are the study of metal surfaces and inclusions by reflected polarized light and the optical study of resins and plastics. But it is felt that enough has been said to gain, at least in part, the objective stated at the beginning. In closing, it is well to emphasize one fact which is embodied in a quotation[13] from Prof. C. W. Mason of Cornell: ". . . the microscope is no more than a versatile tool. The most indispensable accessory of all is not an attachment, but rests upon the shoulders of the observer; it consists of two main parts, eye and brain."

[11] W. D. M. Bryant, "Optical Crystallographic Studies with the Polarizing Microscope. I. Identification and Semiquantitative Determination of Acetic and Propionic p-Bromoanilides in Their Binary Mixtures," *Journal*, Am. Chemical Soc., Vol. 60, p. 1394 (1938).

[12] C. J. Frosch and E. A. Hauser, "Fluorescent Light Microscopy," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 8, p. 423 (1936).

[13] C. W. Mason, "Microscopic Methods in Analytical Chemistry," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 2, p. 203 (1930).

LEADING MICROCHEMICAL TEXT BOOKS

1. Organic Microchemical Analysis:

Pregl and Roth, "Quantitative Organische Mikroanalyse," Fourth Edition, Julius Springer, Berlin (1935).

Pregl and Roth, "Quantitative Organic Microanalysis," English translation of above edition by E. B. Daw, P. Blakiston's Son and Co., Philadelphia, Pa. (1937).

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Lindner, "Mikro-massanalytische Bestimmung des Kohlenstoffes und Wasserstoffes," Verlag Chemie, Berlin (1935).

Boëtius, "Über die Fehlerquellen bei der Mikroanalytischen Bestimmung des Kohlen- und Wasserstoffes," Verlag Chemie, Berlin (1931).

Niederl, "Micromethods of Quantitative Organic Elementary Analysis," John Wiley and Sons, Inc., New York City (1938).

Behrens-Kley, "Organische Mikroanalyse" (Qualitative Identification), L. Voss, Leipzig (1922).

2. Chemical Microscopy:

Chamot and Mason, "Handbook of Chemical Microscopy," 2 volumes, John Wiley and Sons, Inc., New York City (1930). (Vol. 1 of Second Edition just published, 1938.)

Emich, "Lehrbuch der Mikrochemie," J. F. Bergmann, Munich (1926).

Emich, "Mikrochemisches Praktikum," J. F. Bergmann, Munich (1931).

Emich, "Microchemical Laboratory Manual," English translation of above by F. Schneider, Microchemical Service, Douglaston, N. Y. (1935).

3. Inorganic Microchemical Analysis:

Emich, "Lehrbuch der Mikrochemie," "Mikrochemisches Praktikum," and "Microchemical Laboratory Manual"—see above.

Benedetti, Pichler and Spikes, "Microtechnique of Inorganic Qualitative Analysis," Microchemical Service, Douglaston, N. Y. (1935).

4. Analysis by Spot Tests:

Feigl, "Qualitative Analyse mit Hilfe von Tüpfelreaktionen," Third Edition, Akademische Verlagsgesellschaft, Leipzig (1938).

Feigl, "Qualitative Analysis by Spot Tests. Inorganic and Organic Applications," English translation of above (Second Edition) by Janet Matthews, Nordemann Publishing Co., New York City (1937).

Industrial Applications of New Tests at Detroit District Meeting

The technical feature of the Fourth Annual Spring Meeting sponsored by the Detroit District Committee held at the Detroit Leland Hotel on April 19, was a Symposium on Industrial Applications of New Testing Methods. This was preceded by an informal dinner. There was a good attendance at both the dinner and session with upwards of 150 present at the latter.

President T. G. Delbridge and Secretary-Treasurer C. L. Warwick were present and gave short talks. Doctor Delbridge expressed the appreciation of the Executive Committee for the work which the Detroit members had done in connection with their meetings and in other ways in helping to advance A.S.T.M. work. There had been discussion among the local members of one point considered important, namely, stimulating more definite interest on the part of the younger technical men. One way of doing this is, of course, the sponsoring of local meetings with papers or addresses that will be of interest. In general it has been the policy of District Committees to sponsor one or two well planned meetings during the year rather than to hold them more frequently. Each of the Detroit meetings has done much to further A.S.T.M. work. Doctor Delbridge also described very briefly the retirement plan for the employees of the Society which had been established during the past year, since he thought this would be of interest to the Detroit group.

Secretary-Treasurer Warwick pointed out that while membership was still not quite up to 1930, the standardization work had increased as far as output is concerned about 70 per cent and financing this was made possible largely through increasing sales of publications. Some of the major topics coming up at the annual meeting were mentioned and he also gave salient facts concerning the 1939 Book of Standards

to be available in November of this year.

The Symposium on Industrial Applications of New Testing Methods comprised the following papers:

Steels for High-Temperature Service and Their Testing—A. E. White, Director of Department of Engineering Research, and Professor of Metallurgical Engineering, University of Michigan.

New Oil Oxidation Tests Correlated with Service—H. C. Mougey, Assistant Technical Director and Chief Chemist, Research Laboratories, General Motors Corp.

Methods of Industrial Hygiene Procedure and Testing—G. C. Harrold, Chief Chemist, Industrial Hygiene Dept., Chrysler Corp.

Microscopic and Drop Test Methods on Metallic Electrodeposits—J. W. Higgins, Chief Chemist, Packard Motor Car Co.

Doctor White pointed to the importance of various factors, production methods, metallographic constituents and distribution and grain size as affecting properties of steels. Creep properties of a given steel of presumably the same chemical composition are affected as much as 100 per cent by the type and size of metallographic constituents. The various tests used for determining high-temperature service were covered including, in particular, short-time high-temperature tests—tension creep, stress rupture tests, and tests for service stability.

C. T. Van Dusen, Inspection Engineer, The Detroit Edison Co., Detroit, Mich., in discussing high-temperature service, compared certain laboratory and field tests on thin-wall tubing. A fair degree of agreement was noted. Work on degree and rate of scale formation of certain alloy steels used in superheater pipes showed after 3800 and 7600 hr. exposure that scale formed more rapidly at first, then tapered off as the exposure lengthened.

H. C. Mougey described extensive tests on engine oils in an effort to correlate new oxidation tests for service data. Four-thousand mile runs were used with varying operating conditions. Temperature was found to be a most important factor affecting condition of the oil and its effect on engine surfaces. Studies were made after inhibitors and catalysts had been added to different grades of oils. B. E. Sibley, Continental Oil Co., presented discussion of Mr. Mougey's paper.

Dust and ventilation problems in industrial operations were covered by Doctor Harrold, including description of methods and equipment for collecting and measuring the quantity of various types of particles, gases, vapors and the like. Some of the difficulties in this work were stressed, including that of obtaining representative and sufficiently large samples for test. Dr. H. Walworth, Department of Hygiene, City of Detroit, read a discussion prepared by Doctor Fredericks, the head of this department.

In his paper Mr. Higgins pointed out that electro-platings have two chief purposes: added appearance or improved protection. In the case of the former, quality of the plate is important, while on those for protection, thickness measurements are necessary. Equipment and procedures for making drop tests on cadmium, zinc, and chromium platings were covered, and also microscopic tests for other electrodeposits. Mr. Saltonstall of The Udylite Co., gave discussion of this paper.

T. A. Boyd, Head, Fuel Dept., Research Laboratories Division, General Motors Corp., chairman of the Detroit District Committee, presided at the meetings and thanked the members of the District Committee who were responsible for the various matters incident to it, including the dinner, program, invitations, registration and the like, including C. H. Fellows, Head, Chemical Division, Research Dept., The Detroit Edison Co., secretary of the committee; Martin Castricum, U. S. Rubber Co.; V. M. Darsey, Parker Rust Proof Co.; W. C. DuComb, W. C. DuComb Co., Inc.; C. E. Heussner, Chrysler Corp.; and W. P. Putnam, The Detroit Testing Laboratory.

Interesting Meeting in Cleveland

SPONSORED by the Cleveland District Committee, with the assistance of the Cleveland Engineering Society, an interesting meeting of members and guests in the Cleveland District was held in Guildhall on April 20. Following dinner, the group adjourned to the meeting room of the C.E.S. where Chairman James H. Herron called the meeting to order with something under a hundred present.

Mr. Herron presented Secretary-Treasurer C. L. Warwick, who spoke of some phases of the Society's work. He pointed out the marked increase in A.S.T.M. standards—how there is an ever wider acceptance of these standards and how public sale of standards and other Society publications was growing very satisfactorily. He indicated the desire of the Executive Committee of the Society to increase the number of sustaining members, in connection with which there had been quite a satisfactory growth recently.

The change in methods of publishing A.S.T.M. standards is from all indications being most favorably received. He closed his remarks by extending a cordial invitation to all present—members and guests—to attend the annual meeting of the Society in Atlantic City, June 26 to 30, inclusive.

Mr. Arthur W. Carpenter, Manager of Testing Laboratories, The B. F. Goodrich Co., secretary of Committee D-11 on Rubber Products, presented a very interesting paper entitled "A.S.T.M. in the Rubber Industry." This paper covered the great importance of having adequate methods of testing prior to developing specification requirements. Some of the problems which confronted the rubber committee were discussed, and one point was emphasized, namely, that "rubber" is a general term and like the word "metal" may refer to a large variety of materials having widely different characteristics. There are a great many different compositions, one company alone producing nearly 1200 kinds of rubber compositions.

Mr. E. E. Ware, Technical Director of the Sherwin-Williams Co., next discussed in a very interesting manner how A.S.T.M. specifications serve industry in general and the paint industry in particular. He indicated how, with the growth of technical control in the paint and coatings fields, A.S.T.M. specifications were practically essential.

As the concluding talk, the President, T. G. Delbridge, Manager, Research and Development Dept., The Atlantic Refining Co., first stated his growing continued respect for the work of the Society and the increase in the use of A.S.T.M. standards and specifications, which he has come to appreciate due to his recent contact with management questions of the organization. He then showed how these specifications were of most definite assistance to the petroleum field.

General arrangements for the meeting were in the charge of the chairman, J. H. Herron, President, The James H. Herron Co., and the secretary, Arthur J. Tuscany, of Tuscany, Turner and Associates.

Committee D-13 and Its Relation to the Textile Industry[1]

By H. J. Ball[2]

EDITOR'S NOTE.—This paper was part of the program at the March meeting of Committee D-13 celebrating the twenty-fifth anniversary of the committee. While bearing directly on the textile and related fields, it should be of interest to many members in other industries. An excellent exposition of the many valuable contributions of this committee and the significance of its work, it also is in one sense an example that applies with equal appropriateness to many of the other A.S.T.M. committees. The activities of Committee D-13 have accelerated and expanded greatly, especially in the past few years. In all committees executive direction is extremely important in the successful handling of the standardization and research work. Intensely interested in their committee's activities, the officers of D-13 have contributed immeasurably to its outstanding accomplishments and this opportunity is taken to pay tribute to their faithful and untiring efforts.

IT is the purpose of this paper to set forth the important benefits which have accrued to the textile industry, and others closely allied to it, because of the standards for textiles established by the activity of A.S.T.M. Committee D-13 on Textile Materials. It will be necessary first to make clear how the committee is organized to handle the standardization work of an industry with such a variety of fiber groups, and to give in some detail the manner in which its standards are prepared. Without this background it is not possible to appreciate fully what such a standard represents, nor the extent to which it is a well-considered expression of the best available thought and experience on a particular subject matter.

Committee D-13 is the textile committee of the American Society for Testing Materials. This Society is a national technical society organized for "the promotion of knowledge of the materials of engineering, and for the standardization of specifications and the methods of testing." Its work is based on the principle that a suitable standard can only be developed through the cooperation of all interests. Its members are therefore classified as producers, consumers, and general interests, and the regulations of the Society provide that an appropriate balance of interest must be maintained between these several classifications of members on any group charged with the drafting of a standard. It is emphasized that this is a most important and valuable feature, characteristic of the American Society for Testing Materials, and found in no other national standardizing body in this country.

Committee D-13 is one of the largest standing committees of the Society. Its present membership is 212, made up of 91 producers, 51 consumers, and 70 general interests. The character of its membership is indicated by the fact that it includes the names of a large number of the leading manufacturers in the various branches of the textile industry, many large manufacturers who use quantities of textile materials as a component of their products, most of the large mail-order houses and chain store organizations handling textile goods, consumer advisory groups, as well as government departments and bureaus, commercial testing organizations, colleges and technical schools.

The particular scope of work of Committee D-13 is the formulation of definitions, methods of test, and specifications pertaining to textile products, including the materials entering into their manufacture. To cover this comprehensive field in an adequate manner, the committee has organized two major subcommittee groups, designated A and B. The A subcommittees are those which deal with specific fibers and their products, and separate subcommittees have been set up for cotton, rayon, wool, asbestos, glass, bast and leaf fibers, and household and garment fabrics. The B subcommittees are those which deal with phases of the standardization work more or less common to all the fiber groups previously mentioned. For example, the B subcommittees handle such matters as general methods of test, testing machines, atmospheric conditions, definitions and nomenclature, sampling, interpretation and presentation of data, and the activities relating to bleaching, dyeing and finishing.

Each of the A subcommittees are recognized by Committee D-13 as being the group primarily responsible for the development of standards covering their particular fiber field. They are the only groups which may prepare material specifications. They may and usually do draw upon the knowledge and experience of the B subcommittees in the preparation of test methods in order to preserve as much uniformity as possible in the testing procedures used by the industry as a whole.

The subcommittees in both the A and B groups are subdivided, when necessary, into smaller units called sections. These are organized to handle specific intermediate forms of textile materials or specific end products. For example, the A subcommittee on cotton has separate sections dealing with (1) cotton fiber, (2) cotton yarns and threads, (3) light and medium woven fabrics, (4) heavy woven fabrics, (5) tire fabrics, and (6) narrow fabrics. The A subcommittee on wool has found it advantageous to have separate sections for (1) the wool fiber (2) woolen and worsted yarns, (3) woolen and worsted fabrics, (4) wool felt, and (5) pile floor coverings. As a further example, one of the B subcommittees divides its work between three sections entitled (1) methods, (2) machines, and (3) atmospheric conditions.

These subcommittees and sections of Committee D-13 are the real workshops of the committee. It is here that the standards are developed. It is in the meetings of these smaller groups, and by correspondence as well, that each detail of a proposed standard is minutely examined and discussed. Methods of test are not considered acceptable until they have been subjected to carefully planned interlaboratory tests conducted by members of the group. The proposed methods must give evidence that they will yield reproducible results of satisfactory precision when carried out by different operators. Definitions of words and terms,

[1] Presented at the meeting of Committee D-13 on Textile Materials, Providence, R. I., March 1 to 3, 1939.

[2] Chairman of Committee D-13 and Professor of Textile Engineering, Lowell Textile Inst., Lowell, Mass.

choices of phraseology are all studied carefully, to be sure that the correct technical shade of meaning has been expressed and that ambiguity has been eliminated. When physical and chemical properties of a material are to be specified, they are established, together with appropriate tolerances, with due regard to the practicability of producing such results, and to the requirements and the needs of those who will use the textile.

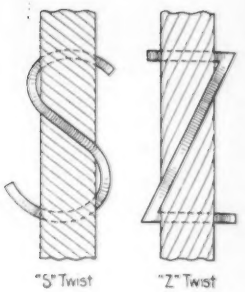
Final satisfaction with a proposal must be indicated by a letter ballot sent to all members of the originating group. This is then followed by a letter ballot of the entire membership of Committee D-13 on the question of accepting the standard. If this is in the affirmative, the standard is then offered to the Society as one bearing the approval of and sponsored by Committee D-13. According to the rules of the Society, it normally remains in a tentative status for one year, but not more than three years without cause. This is provided so that the industry can give the standard a more thorough trial and thus test it for defects. If any do develop, the tentative standard is revised. If not, the final step is to advance it to a standard status. This action is started by the originating section or subcommittee and the steps are the same as those through which it was originally passed.

The Society has a very wise provision that final standards must be reviewed by their sponsor every sixth year to determine whether or not they are meeting the needs of the industry. This is obviously designed to prevent them from becoming obsolete. It should be noted further that no standard is considered as an ultimate finality. It is regarded as an expression of the best to date, and may be modified or displaced whenever new technical developments, improvements in testing equipment, refinements in technique, and the demands of progress indicate the desirability for an improved standard.

These are the steps by which Committee D-13 prepares workable and reliable standards for the use of the industry it serves.

Upon this, the occasion of the twenty-fifth anniversary of the organization of Committee D-13, it is appropriate to survey its accomplishments to determine the extent to which the committee's activities have influenced the industry of which it has become a definite and necessary part. One direct measure of its influence may be comprehended by a study of the 50 standards which it has formulated and which are on its books at the present time. The indirect and equally valuable effects of these years of work and effort are difficult of reduction to a common unit of measure, but that they have been very great and influential no one can deny. The following illustrations are cited in the hope of making clearer their general character and magnitude.

Today, certain of the standards prepared by the committee are nationally known and widely accepted in all divisions of the industry. Such are the following: the specifications for grab, raveled and cut strip fabric test specimens, for standard atmospheric conditions for testing laboratories, for types of testing machines and details of their operation, for the dead weight gage for thickness measurements, the method of determination of twist in yarns, of identification of fibers in mixtures, for measurement of light fastness, the fundamental textile definitions, and the S and Z nomenclature for designation of direction of twist. This latter item has in fact become an international standard through adoption by the International Standards Association Committee 38 on Textiles. The above-mentioned standards alone have unquestionably had a marked influence upon the manufacturing, sales and testing activities of every important producer and consumer in the entire textile field.



For Designation of Direction of Twist

Furthermore, each separate branch of the industry has felt the influence of the particular standards prepared for its own needs. Whereas it is not feasible to attempt to evaluate the effect completely, some of the results are of sufficient importance to warrant special mention. The cotton industry, for example, has been provided with methods of test for that material in all its important forms, namely, fiber, yarn, thread, and the many mechanical fabrics ranging in weight from light to heavy.

The rubber tire industry was the first and has always been one of the most active in the promulgation of standards for cotton textiles. This work has so far advanced that tire textiles are now produced to meet rigid specifications for strength, elongation, twist, weight, and thickness. Inadequacies in these properties are directly reflected in the quality of the tires produced from them, and ultimately in the safety of those who ride on them. This industry quite generally writes into its purchase specifications the D-13 methods of test, and it has been indicated that the D-13 material specifications for tire textiles have resulted in a reduction in the variety of fabrics used in the industry.

The electrical industry is an important consumer of quantities of textile materials for insulating purposes. These are in the form of cotton yarn, sheeting, tubular sleeving, braids, and tape; rayon yarn; silk tape; and asbestos roving, yarn and tape. Representatives of the producers and consumers in these two great industries, following the D-13 procedure, have worked out satisfactory methods of test for each of the above textile products to determine their suitability for the important function of insulating electrical conductors. These standards have been of particular benefit to the asbestos industry. Prior to their adoption, individual manufacturers of electrical apparatus had separate specifications and methods of test which not only differed but placed a hard-

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. . . Disagreements between buyer and seller, and customers' complaints as to quality are frequently settled by use of the D-13 standards in recognition of their fair, reliable, unbiased and authoritative character. Definite reference to them in purchase contracts has tended to eliminate losses and delays through possible misunderstandings and misinterpretations.

ship on the supplier by requiring rather complete and unnecessarily burdensome test apparatus.

The woolen and worsted industry had practically no technical standards until they were supplied through the activity of the wool group of Committee D-13. These standards now provide methods of test for the material in the form of fiber, woolen yarns, worsted yarns, mixture yarns, wool and part wool fabrics, and felt. The test for fineness of wool top has substituted a scientific procedure for one in which the personal equation previously predominated. The test has been made the basis for the grading of tops by the Wool Associates of the New York Cotton Exchange, and the U. S. Department of Agriculture is revising its wool top standards on the basis of those of the American Society for Testing Materials. The committee's standard method of estimating hard scoured wool in wool in the grease is being used by the Treasury Department and the Wool Section of the Department of Agriculture in a large scale set of tests to solve the sampling and scouring problems arising in connection with tariffs and duties. The requirements of the automotive industry as large buyers of wool felt has stimulated interest in this material by the wool group. The result is a carefully drawn set of physical and chemical test methods for this important textile.

That group in Committee D-13 representing the rug and carpet industry has been diligent in providing it with a most comprehensive set of test methods, which is now the guide of that industry. This has come about because its research and testing engineers could meet in the technical atmosphere of Committee D-13 to operate on matters affecting the welfare of the industry as a whole, without having to consider personal and competitive conditions. Under such auspices the units of this industry have found it possible to unite in an extensive wear test program, in cooperation with the National Bureau of Standards, whose results will be of benefit to both the producer and consumer of pile floor coverings.

Standardization activity in the rug and carpet field has spread to the jute industry because it is the supplier of one of the important materials entering into the construction of floor coverings. Work on the development of standards for jute yarns is now in progress. Upon its completion, benefits similar to those which have accrued to other parts of the textile industry will be realized by this relatively new participant in the D-13 workshop. Even this developmental period is not without some real benefits to this group. These are measured by the time and money saved by adoption of standard test conditions which have already been thoroughly investigated and studied by others in the past and reduced to practical form. Such items as standard atmosphere, the effect of capacity of testing machines and the speed of pulling jaw, the methods of determination of twist, and the designation of its direction represent ground which does not need to be traversed again.

The same comments apply with equal force to the glass fiber industry which is the very latest group to join Committee D-13. Many of the fundamentals regarding testing conditions, machines, and definitions are already at hand, ready to be incorporated with little or no change into the standards which it is expected will soon control the testing and properties of glass textiles.

The rayon industry has developed all of its important standardization work under D-13 auspices. Two standards alone cover the entire rayon yarn field, one dealing with filament rayon and the other with yarns and threads made from rayon staple fiber. The extent to which the effect of these standards permeate the whole textile industry will be better conceived when one recalls the phenomenal expansion which has occurred in the past ten to fifteen years in the use of this material. Cotton, woolen, worsted, and silk manufacturers, as well as the knit goods industry, are consumers of enormous quantities of rayon to be turned into yarns and fabrics made wholly of rayon or in combination with the other fibers. The rayon group in Committee D-13 has also provided standards whereby rayon fabrics may be tested for wet strength, shrinkage, slippage, and fastness to washing. It should be noted that the Federal Trade Commission in its rules for the rayon industry has adopted the D-13 definition of rayon. As an illustration of indirect benefits from the work of Committee D-13, one of the rayon producers reports that some of the definitions published by the Society have proven useful in clarifying concepts required in the preparation of patents. The advantages which come from having the various fiber groups working under a common banner is further evidenced in the rayon staple fiber field. It is found that the methods developed by the cotton and wool groups for the sampling and determination of length of cotton and wool fibers, respectively, are quite adaptable to the various class lengths of rayon staple.

Many of the products under the jurisdiction of Committee D-13 are finally converted into a wide variety of articles to satisfy the needs and desires of the so-called ultimate consumer. The interests of this type of consumer in the products of the textile mills has shown a sharp increase in recent years, and there are signs that it will continue to expand. In recognition of this, Committee D-13 has recently organized a group whose function is the preparation of standards for household and garment fabrics. It has done this in the belief that this offers to the textile industry and to those who are closest to the consuming public the most logical meeting place wherein to work out the best compromise standards, practical in their require-

. . . Into the papers and discussions are poured the great wealth of accumulated experience and new knowledge possessed by representatives of government bureaus and departments, by experts and technicians in the research, developmental, and testing laboratories of large industrial plants and consumer establishments, and by those inspired to research in textiles in the schools and colleges throughout the country.

. . . It is highly essential to the industry that those who are most experienced in and who have intimate contact with the standardization work of their respective organizations should serve in the development of the standards. To this end, Committee D-13 invites the continued support of the industry through membership of its qualified men and women.

ments and fair alike to both interests. The results to date are tentative specifications for three important cotton fabrics, namely, broadcloth, sheeting, and terry toweling.

Other benefits have accrued besides those industry-wide ones previously mentioned, and the committee's standards have been used to advantage in many ways by individual units in the industry. Disagreements between buyer and seller, and customers' complaints as to quality are frequently settled by use of the D-13 standards in recognition of their fair, reliable, unbiased and authoritative character. Definite reference to them in purchase contracts has tended to preclude controversy and litigation, and to eliminate losses and delays through possible misunderstandings and misinterpretations.

The standards have served as guide posts to the commercial testing organizations in fulfiiling the many and varied requirements their work entails. The compilation of textile standards, a book containing all the Society's standards relating to textile materials, is found to be a handy ready reference manual in many laboratories, and is used extensively as the text book in classes in textile testing in the schools and colleges. By the committee's work, testing machine builders have been stimulated to develop new and better pieces of testing apparatus and the fact that a piece conforms to an A.S.T.M. requirement is regarded as a mark of approval and distinction. Mill research laboratories have recognized that the D-13 standards may be employed as an effective means for securing reliable processing control. They have been spared the expense of developing laboratory methods of their own and have eliminated much time-consuming controversy within the four walls of their plant by reference to the committee's standards. The use of standard test methods between mills, brokers, selling and commercial houses, and the consumer assures a better comparability of test results as the properties of a material are evaluated by each interested handler in the channels of distribution.

The meetings of Committee D-13 have become one of the most important clearing houses for the exchange of technical information of value to the industry as a whole. Producer, consumer, and general interest members seem willing and anxious to make their contribution to the advancement of the knowledge of textile materials and their properties. Papers presented before the committee as a whole and at the meetings of its subgroups offer the very newest in facts, techniques and developments. This has permitted a coordination, between the divisions of the industry, of the attack on problems of related interest, and has undoubtedly been effective in speeding up research work in individual companies. Into these papers and resulting discussions are poured the great wealth of accumulated experience and new knowledge possessed by representatives of government bureaus and departments, by experts and technicians in the research, developmental, and testing laboratories of large industrial plants and consumer establishments, and by those inspired to research in textiles in the schools and colleges throughout the country.

The work of Committee D-13 has an educational relationship to the industry which should not be overlooked. For example, the development of techniques in the setting up of standards has been of great help in cases where a unit in the industry must establish its own testing methods because no standard exists. By demonstrating how a scientifically sound method should be prepared, it has shown up, and led to the elimination of, unsound ones. The wide representation of interests in Committee D-13, and the substantial body of scientific men which it brings together at its meetings, affords an unexcelled opportunity to broaden one's knowledge, and the contacts made with the minds of others leads to intellectual growth and professional maturity.

It is very clear that the textile industry recognizes in Committee D-13 a central organization, covering the entire fiber field, and doing practical, scientific standardization work of the broadest scope. The continuous growth in the committee's membership and the expansion of its field is excellent evidence of the committee's importance to the industry which it serves. Under its auspices producers and consumers meet in a technical atmosphere, acquire a mutual respect for the other's difficulties, and then cooperate in the solution of their common problems. It is highly essential to the industry that those who are most experienced in and who have intimate contact with the standardization work of their respective organizations should serve in the development of the committee's standards. To this end, Committee D-13 invites the continued support of the industry through membership of its qualified men and women.

The quality of the work which the textile industry has done for itself through Committee D-13, coupled with the prestige and the sensible requirements of the American Society for Testing Materials, has placed its standards in an authoritative position in the industry. This position must not be impaired one iota. Those who put faith in the integrity and scientific character of our work must not have that confidence shaken or violated. To see that the D-13 standards shall be reliable, unbiased, practical, technically correct, and comprehensive, must be the standard upon which the eyes of its officers and committee chairmen are constantly focused. Under such conditions the textile industry will continue to accept Committee D-13's leadership in the standardization field, and its influence will become even more widespread and effective as the years roll by.

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Determining the Adhesive Strength of Gummed Tape[1]

By George H. Harnden[2]

SEVERAL years ago it became necessary to develop a testing machine together with suitable test procedure for determining the adhesive strength of the gummed tape used for sealing corrugated shipping containers. Not wishing to develop an entirely new machine unless absolutely necessary, the gummed tape manufacturers were contacted for information and help. It was learned that a machine had been developed some years before by one of the domestic testing machine manufacturers and that a number of them were already in use by the gummed tape industry. This machine, however, had never given very satisfactory results, particularly on check tests in different laboratories. The gummed tape manufacturers through their association offered their aid in this investigation, and the testing machine manufacturer very kindly cooperated by furnishing a testing machine.

This machine consists of two tables about 6 by 8 in. placed side by side. Each table is hinged at the outer edge on the under side so that the adjacent ends are free to move in an arc. In testing, these are moved by the action of a cam on the end of a weighted lever arm. The action of the tables is intended to duplicate the action of the flaps of a corrugated case after they have been closed and then the pressure removed, allowing them to spring back to the partially open position. In addition to the above, the machine is equipped with suitable trip levers, graduated scale, brackets to hold the test specimen and frame to hold the entire assembly.

In making the tests, a sheet of the test paper about 6 by 10 inches is placed across the top of the two tables and the holding clamps are tightened down securing the ends of the sheet. The test sheet is then slit through the center or directly over the position where the two tables come together. A piece of the gummed tape to be tested is moistened and then placed on this test sheet, and after the proper interval of time the machine is tripped and the adhesive strength taken directly from the scale reading.

Because the degree of uniformity with which the water is distributed over the glue surface of the tape has a great bearing on the drying time, a brush-type tape moistener with a constant water level device was chosen as the tape-moistening medium. This does not necessarily mean that it is superior to the roll-type tape moistener, but for sake of standard testing procedure, the brush-type moistener has been used throughout all of the tests.

Upon receipt of the testing machine, it was set up in conjunction with the brush moistener in such a position as to eliminate in so far as possible any lost motion on the part of the operator. To do this, the moistener was set directly behind the center of the testing machine but at 90 deg. to it, and about 3 in. higher than the top of the tables. This original placing of parts has been carried through the succeeding development to the present setup. By placing the parts in this position the tape is brought out of the moistener directly over the position in which it is to be tested.

During the preliminary testing program, which consisted of approximately 900 individual tests on a large number of different tapes, certain standards for future testing were set up. After experimenting with several different kinds of test sheets, such as kraft linerboard, jute linerboard, and several types of heavy kraft paper, etc., it was finally decided to use a 90-lb. calendered kraft sheet, 6 by 9-in. size. This was readily obtainable and of unvarying quality and finish, these points making it quite desirable for adoption from a standards point of view. A test specimen of 3-in. gummed tape, 5½ in. long was adopted as standard, the reason for this being that the 3-in. width was the most popular width used. As the machine table as well as the test sheet was 6 in. wide, it was felt the 5½-in. length would be adequate as far as a representative test was concerned, and at the same time it allowed the operator a little leeway in placing the sample on the test sheet. A 5-sec. test period was adopted as standard. This was determined from a series of tests which indicated that 2½ sec. was as fast as an operator could work with any degree of accuracy in repetitive operation. Also, after a test period of 8 sec. was reached, there was no increase in adhesive strength with increase in time. As many operations in shipping departments are very rapid, some being not more than 4 or 5 sec., it was decided to duplicate as far as possible this time.

At first all tests were made in a conditioned atmosphere of 65 per cent relative humidity and 72 F., but later it was determined that the tape needed only to be humidified and tests could be made anywhere as long as the interval of time between conditioning room and testing was not too great. Tests on conditioned tape compared with uncondi-

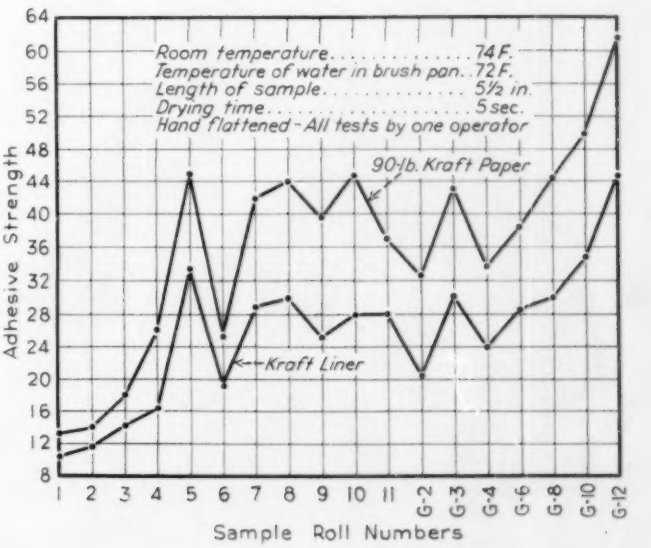


FIG. 1.—Comparison of Adhesive Strength at 25 per cent Relative Humidity with Test Sheets of 90-lb. Kraft Paper and 0.016-in. thick Kraft Liner Board.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] Presented at a meeting of Committee D-6 on Paper and Paper Products, New York City, April 4, 1939.

[2] Engineer, General Electric Co., Schenectady, N. Y.

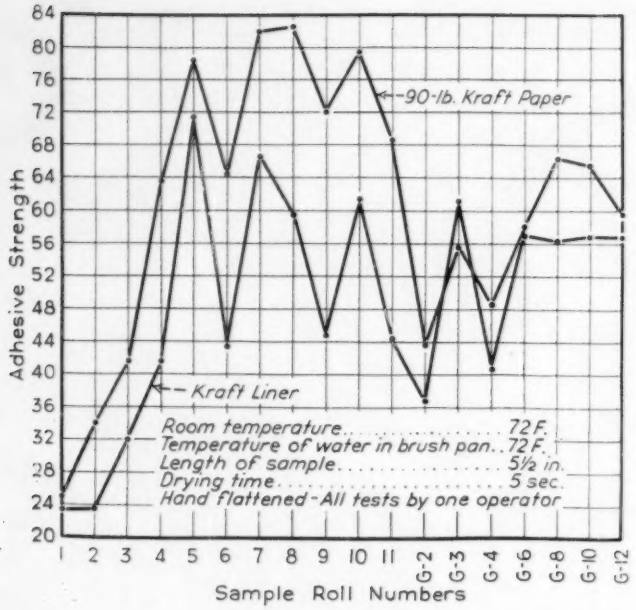


FIG. 2.—Comparison of Adhesive Strength at 65 per cent Relative Humidity with Test Sheets of 90-lb. Kraft Paper and 0.016-in. thick Kraft Liner Board.

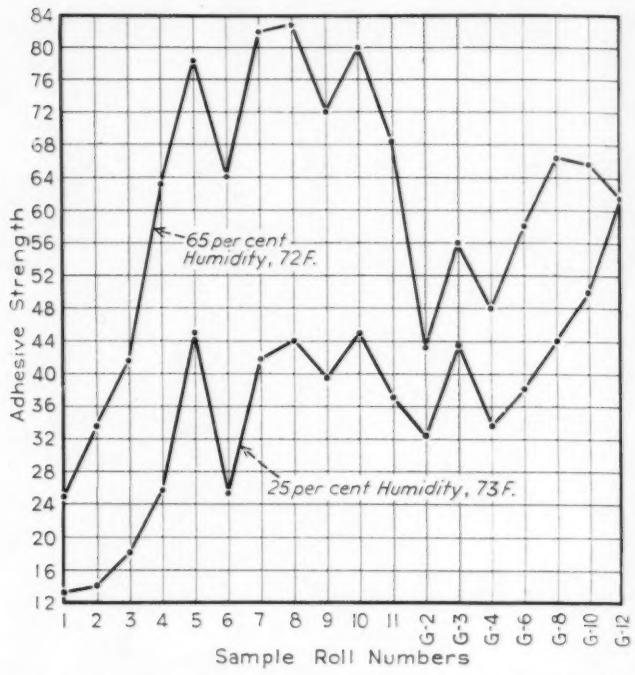


FIG. 3.—Comparisons of Adhesive Strength at Different Relative Humidities with Test Sheets of 90-lb. Kraft Paper. All other conditions being same as for Figs. 1 and 2.

tioned tape indicated that the conditioning raised the adhesive strength approximately 40 per cent.

Figures 1 to 3 show the results of the investigation of the type of test sheet to use as well as the degree of relative humidity necessary for test conditions. On all samples but one, the 90-lb. kraft test sheet gave a more favorable reading under all humidity conditions, although as the humidity increased the spread between the values for the different types of test sheets decreased.

Experiment indicated that it was quite necessary and important that pressure of some kind be applied to the test sample after it had been laid on the test sheet. At first this pressure was applied by merely rubbing the hand over the sheet several times. This, however, was found to be one of the major sources of error in readings, as the results could be varied by at least 75 per cent depending on the operator and amount of pressure exerted. Hand-rubbing was replaced by an ordinary rubber roller similar to those used for photographic work. This consisted of a wooden roller $3\frac{3}{4}$ in. long and $\frac{3}{4}$ in. in diameter with a $\frac{1}{16}$-in. rubber covering. A rolling cycle of 5 times, across and back over the sheet counting as one cycle, was set up and many tests made. It was found that a tall operator would exert more pressure on the roller than a short operator, thereby obtaining consistently higher readings. Figure 4 shows results of these tests. While the use of this roller did not entirely eliminate the error, it indicated a step in the right direction. By using the same operator for all tests, results checked fairly well. Following this the advisability of using either a flat weight or a new type roller weight was investigated. Flat weights were made up, each having a rubber covered contact surface 4 in. wide by 6 in. long and weighing respectively 3.5 lb., 6.5 lb., 18 lb., and 29.5 lb. Figure 5 shows the different weights experimented with in this investigation.

These flat weights, besides not giving the proper smoothing action to the test specimen, were extremely clumsy to use and were therefore quickly discarded. These tests, however, did indicate that more consistent results were obtained with the heavier weights. Therefore, a solid iron roller

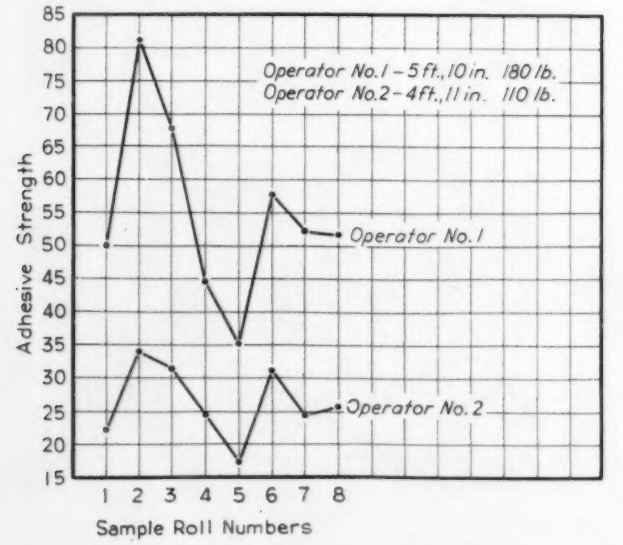


FIG. 4.—Comparison of Adhesive Strength When Checked by Two Different Operators—Each Using Small Rubber Roller to Smooth Test Specimen.

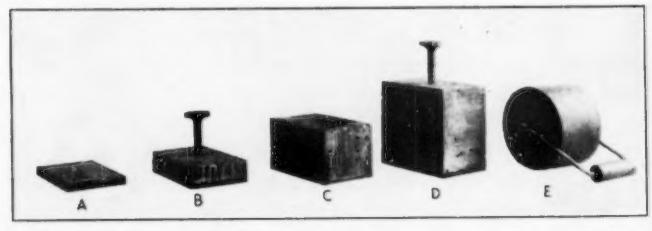


FIG. 5.—Various Weights Used in the Investigation of the Shearing Strength of Gummed Tape.
A—3.5 lb. *B*—6.5 lb. *C*—18.0 lb. *D*—29.5 lb. *E*—16.5 lb.

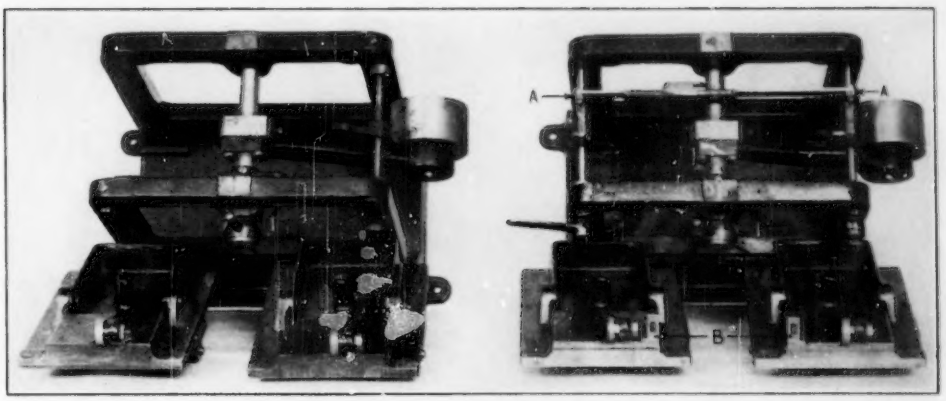


FIG. 6.—Old and New McLaurin Gummed-Tape Testers.

New machine, on right, has new locking lever *A* on framework and locking clips *B* on each table.

weight was made which was 3½ in. in width, 4½ in. in diameter, weighing 16.5 lb., and having a ¼-in. thick sponge rubber covering on the circumferential surface. This weight was built so that no pressure could be exerted on it by the operator; it was easily handled in the short-time test period and gave quite consistent results. This roller weight was finally standardized in conjunction with a two-cycle rolling operation or two complete passes across the test sheet.

Even with these standards which had been set up, there was still a considerable variation in test results. The amount of glue on the surface of the tape was investigated, and while small differences in each 5½-in. length were found they did not seem to be enough to account for the wide differences in test values. Because two different operators could not check each other on the same sample of tape, attention was centered on improving the testing machine and the elimination, in so far as possible, of the human element in testing by making the machine semiautomatic in operation. Recommendations were made to the testing machine manufacturer which meant the virtual rebuilding of the machine. The more important of these were: change in bearing design to antifriction enclosed bearings, change in cams and tripping linkage, change in pointer and scale graduations, the addition of a shelf at the back of the machine to hold the weighted roller, as well as a new locking device to hold tables stationary and level until the machine was tripped, etc.

Following these recommendations two testing machines were rebuilt for the continuation of this investigation. Figure 6 shows one of the major changes: the addition of a positive locking device on the under side of the tables and framework which holds the tables stationary until the machine is tripped.

Tests on the same samples of tape made on both machines did not check closely enough for standardization purposes. A calibrating instrument was developed, and it was found that by making slight changes in the testing machines adhesive tests made on the two machines checked very closely with each other. This development indicated that it was possible to build these machines in any number and calibrate each so that all of them would give the same results when leaving the factory. Figure 7 illustrates the new calibrating device in position on the testing machine.

From this point all efforts were toward making the machine semiautomatic to eliminate as far as practicable the human element in testing. The testing machine was permanently mounted on a platform with the moistener on a framework behind it. An electric timer was introduced with necessary switches as well as a solenoid coil for tripping the machine. With this arrangement it is possible to make consecutive tests with an error in time element of but 0.25 sec. This is very important as it was found in working with short time intervals for drying, each 0.10 sec. changes the adhesive strength of the tape. Figures 8 and 9 show the side and end views of the apparatus in its present developed condition as described above.

Approximately 15,000 individual tests on gummed tape have been made on this rebuilt apparatus. Many interesting questions have arisen as a result of these tests, some of which have not to date been answered satisfactorily. In some instances as many as 450 consecutive tests have been made on one roll of tape (representing about 200 ft.) to determine why variations in adhesive quality occur generally in definite cycles throughout the roll. To illustrate, Fig. 10 gives the

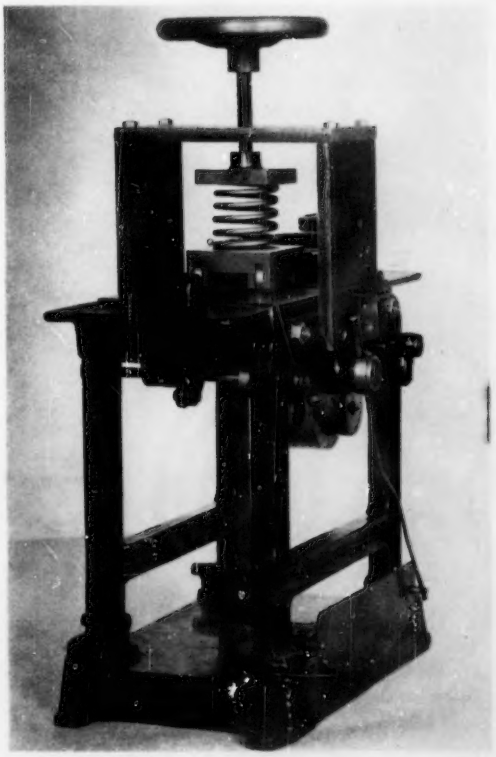
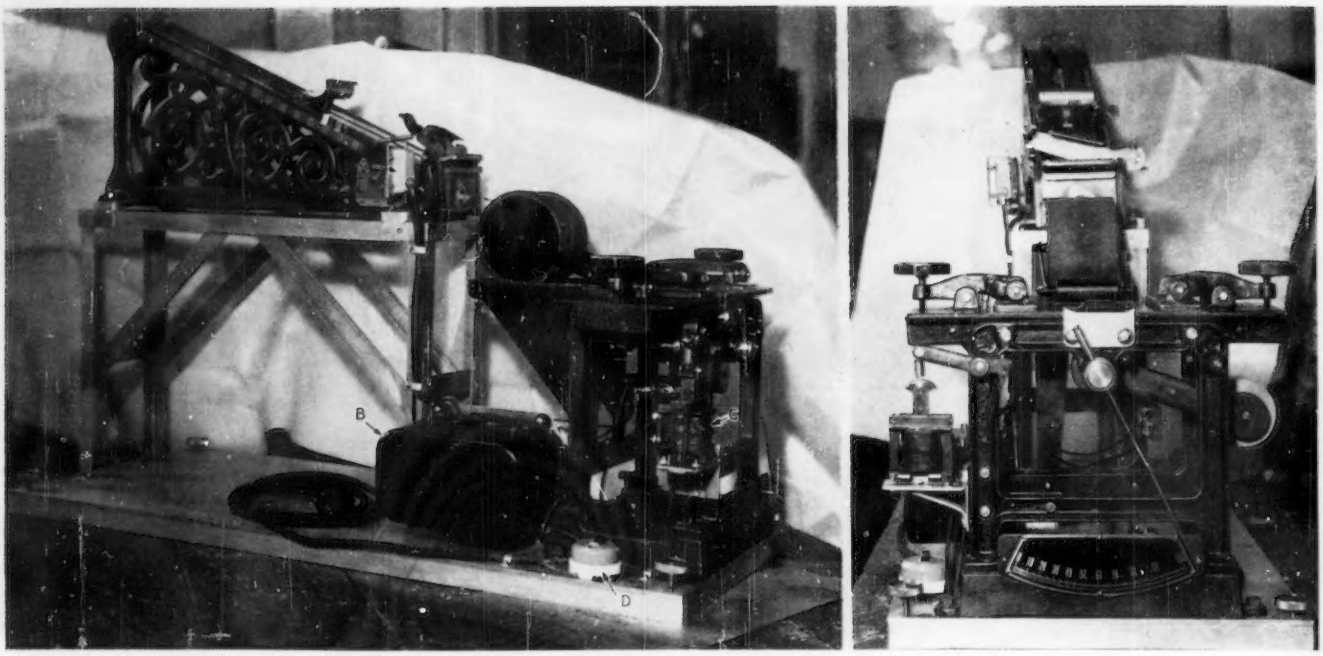


FIG. 7.—New Calibrating Instrument Completely Assembled and in Position for Calibrating Machine.



FIGS. 8 and 9.—McLaurin Gummed Tape Testing Machine
Left.—Side View Showing Timing and Tripping Devices. (A) Timer Switch, (B) Timer, (C) Solenoid Trip, and (D) Main Line Switch. Right.—End View Showing Timing and Tripping Devices.

results of 146 consecutive tests on a roll of tape. The first 15 tests (approximately 8 ft.) indicated that the strength of the glue was gradually increasing. These same results were duplicated on many different samples of tape, but for no apparent reason. To eliminate these low readings the first 10 or 15 ft. of each sample roll is discarded before testing. The balance of the curve indicates fairly consistent adhesive quality but very low strength. This tape would give very unsatisfactory results in actual use. Figure 11 shows the results of adhesive strength tests on another sample roll of tape. Notice the difference in the average strength between this tape and that shown on Fig. 10 (43 points), a difference which means success or failure of the tape in use. Actual service tests in the factory and laboratory tests on this apparatus indicate that when the average falls below 65 points with a minimum of 60 points for any one reading, the tape gives trouble particularly where speed of application is essential.

As a result of this investigation one consumer has set up requirements on adhesive quality for all tape purchased as follows: "Using a 5-sec. drying time, the adhesive quality of gummed tape conditioned at 50 to 65 per cent relative humidity at 72 F. shall not be less than 65 average for 50 consecutive tests with no single test less than 60."

In conclusion, it should be pointed out that while this investigation has aided in setting up adhesive standards and methods of test, it has not sufficiently answered many questions regarding the variation in adhesive strength of gum-

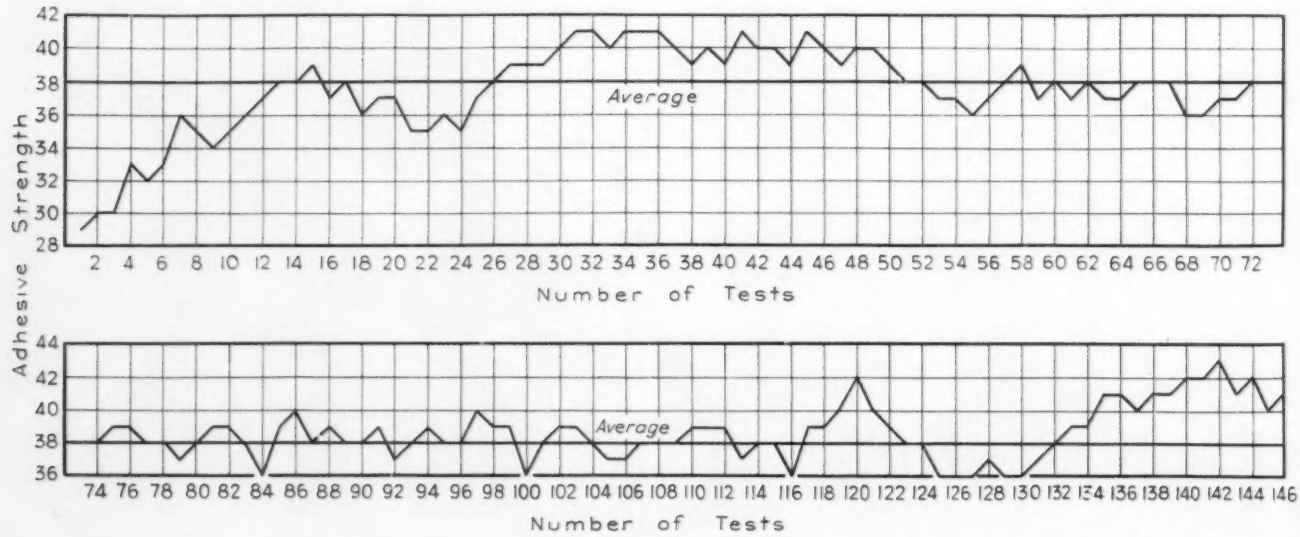


FIG. 10.—Comparison of 146 Successive Individual Adhesive Strength Tests on one Roll of 3-in. wide, 60-lb. Kraft Tape. Covers approximately 68 ft.

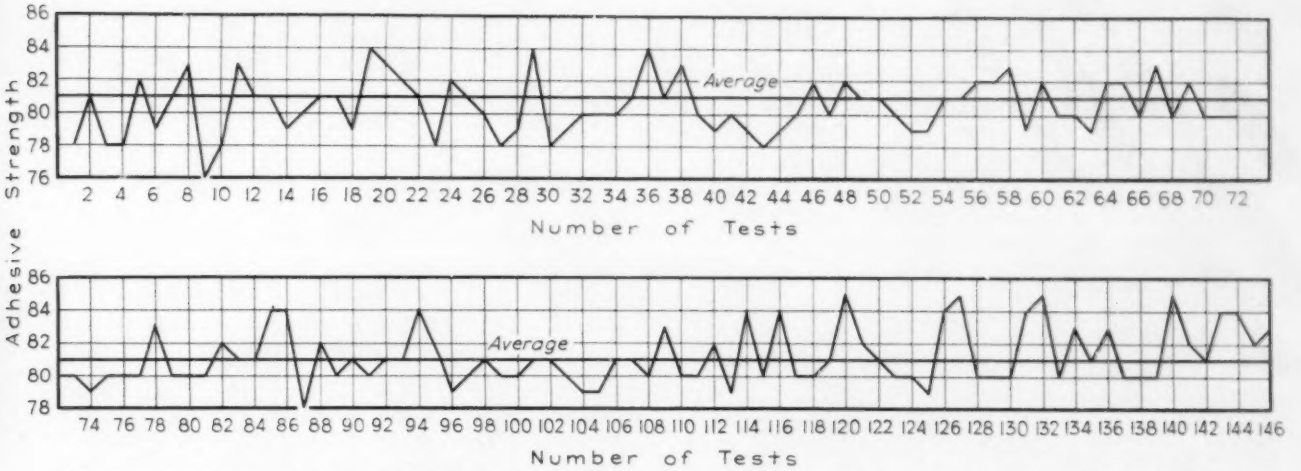


FIG. 11.—Comparison of 146 Successive Individual Adhesive Strength Tests on one Roll of 3-in. wide, 60-lb Kraft Tape. Covers approximately 68 ft.

med tape. Further work must be carried on to obtain the true answer, investigations on the glue, on the paper used in the manufacture of gummed tape, on the manufacturing technique as applied to gummed tape, and further development of the testing machine must be carried on simultaneously. Each of these varied investigations should be of interest to the industry at large, both the manufacturer and the consumer, and because of the large amount of investigational work entailed, is hardly within the scope of a consumer testing laboratory.

Uniformity of Property Values in Similarly Made Steels[1]

By Daniel J. Martin[2] and James L. Martin[3]

RESEARCH in the development of new steels always presents the problem, among many others, of the significance of the mechanical property results obtained, their duplication in heats made as nearly alike as possible, and the distinction between variations in properties that should be considered normal for any two like ingots, and those which may properly be classed as effective and desired changes. It is the object of this discussion to report upon the results obtained and the variations encountered in a series of three 60-lb. ingots made in an acid-lined high-frequency furnace under carefully controlled conditions.

Experimental Conditions

The ingots were made from consecutive heats in a furnace, the lining of which had been broken in and did not require patching before or during the sequence of heats involved. The charges were made up from the same lots of ingot iron, Chateaugay pig iron, and ferro-alloys. A record of the details of manufacture of the ingots is set forth in Table I. Melting conditions were as nearly uniform as possible and temperatures were taken with a platinum — platinum-rhodium couple. A 4 by 4-in. rectangular mold was used, and the mold temperature just before pouring was taken by means of a chromel-alumel couple. Both couples were checked for calibration before and after this series of heats. The ingots were stripped and buried in ashes exactly ten minutes after the end of pouring.

Table I.—Details of Melting Practice.

Ingot	Time Before Start of Pour, Min. Total Time for Heat	All Molten	Mn Added	Si Added	Settling Time Power Off to Start of Pour, min. and sec.
A	45	11	6	4	2:00
B	42	9	5	4	1:58
C	42	10	5	4	2:00

Ingot	Temperature, deg. Cent. Maximum	Pouring	Mold
A	1610	1560	320
B	1620	1570	325
C	1600	1550	310

The ingots were about 12 in. long, not including the hot top. The bottom 2 in. was cut off and discarded. The next 6 in. from the bottom was used for test. These 6-in. pieces were reduced in forging about 3 to 1 to a 2¼-in. round. The pieces were heated together to 1175 C. in 6 hr., were soaked at that temperature for 4 hr., and forged the entire amount from this one heating, the finishing temperature being 845 ± 20 C.

The forged bars were given the following heat treatment:

Normalize—4 hr., at 950 C., cooled in still air.
Quench —4 hr., at 850 C., cooled in water at 20 C.
Temper —4 hr., at 600 C., cooled in air.

After heat treatment, standard 0.505-in. tension test bars and tension Charpy impact bars were taken at half radius, in the direction of forging, from the same longitudinal position, starting 1 in. up from the bottom of the bar; that is, from metal that was originally nearest to the bottom of the ingot. Transverse 0.252-in. tension bars and transverse tension Charpy impact bars, with their axes at half the radius of the forged bar, were taken from the same location 1 in. above the top of the longitudinal bars.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] Released for publication by the Chief of Ordnance, U. S. Army. Statements and opinions are to be understood as individual expressions of their author, and not those of the Ordnance Department.

[2] Captain, Ordnance Dept., U. S. Army, West Point, N. Y.

[3] Assistant Metallurgist, Watertown Arsenal, Watertown, Mass.

Results

Chips taken from the same location in each ingot, including metal from ½ to ¾ in. from the outside of the center of the wall of the ingot 6½ in. up from its bottom end, gave the analyses shown in Table II.

Table II.—Chemical Analysis of Ingots.

Ingot	*Carbon, per cent*	*Manganese, per cent*	*Phosphorus, per cent*	*Sulfur, per cent*	*Silicon, per cent*
A	0.43	0.72	0.009	0.021	0.28
B	0.41	0.77	0.009	0.019	0.24
C	0.43	0.77	0.009	0.021	0.25

All tension bars were tested at the same speed in an Amsler testing machine. The tensile Charpy bars were broken in the small standard Charpy machine at an impact velocity of 16 ft. per sec. The results of the longitudinal and transverse tests are given in Table III.

Table III.—Longitudinal and Transverse Properties.

Ingot	Test Bar	Tensile Strength, psi.	Proportional Limit, psi.	Elongation, per cent		Reduction of Area, per cent	Charpy Impact, ft-lb.
				in 2 in.	in 1.4 in.		
Longitudinal Bars							
A	1	93 000	65 000	25.5	.....	65.1	7.3
	2	93 000	66 000	25.5	.....	65.6	7.9
B	1	102 500	68 000	24.0	.....	64.0	7.9
	2	102 500	69 000	25.0	.....	64.0	4.0
C	1	98 250	65 000	25.5	.....	63.5	8.0
	2	99 000	66 000	24.0	.....	64.2	2.2
Transverse Bars							
A	1	94 400	58 000	.....	23.0	51.6	1.9
	2	93 000	56 000	.....	21.0	51.5	3.9
B	1	98 600	58 000	.....	21.0	49.8	4.2
	2	98 000	56 000	.....	23.0	55.8	2.4
C	1	96 400	52 000	.....	22.0	49.2	8.6
	2	96 400	56 000	.....	24.0	54.8	10.3

Discussion

It is felt that the variables always encountered in this type of work were reduced to a minimum and that the results therefore represent those which may normally be expected in a laboratory effort to make ingots as nearly alike as possible. A study of the data obtained is of interest because it indicates the need for more reliable information concerning the range of properties to be expected from similar heats. Tabulations and graphs showing the average properties of the various steels are plentiful and in close agreement. Very little, however, has been reported to show the spread to be expected in any one of the many properties, or the deviation from the average.

A statistical analysis of a large number of heats of the same steel made as described above would give a very definite picture of the uniformity which should be expected. An indication of what this may be has been secured by taking the spread in properties from the above data, the mean, and the maximum deviation from the mean, in figures, and as a percentage of the mean (Table V).

The values shown for the tensile properties seem reasonable and require no further comment. The wide variation in impact values is but additional evidence of the irregularity of the impact resistance of plain carbon steels, even after heat treatment.

The authors wish to acknowledge the kind interest and encouragement of Colonel G. F. Jenks, Ordnance Dept., U. S. Army, who was Commanding Officer of Watertown Arsenal at the time this work was performed.

Table V.—Study of Property Data.

	Tensile Strength, psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Charpy Impact, ft-lb.
Longitudinal Bars					
1. Maximum spread	9 500	4 000	1.5	2.1	5.8
2. Mean	98 042	66 500	24.9	64.4	6.2
3. Maximum deviation from (2).	5 042	2 500	0.9	1.2	4.0
4. (3) as percentage of (2)	5.14%	3.76%	3.61%	1.87%	64.6%
Transverse Bars					
1. Maximum spread	5 600	6 000	3.0	6.0	8.4
2. Mean	96 133	56 000	22.3	52.1	5.2
3. Maximum deviation from (2).	3 133	4 000	1.7	3.7	5.1
4. (3) as percentage of (2)	3.26%	7.15%	7.46%	7.1%	±100%

Important Standards Actions at Soap Meeting

ATTENTION is directed (see page 2 of this issue) to ization work were announced as a result of the meeting of Committee D-12 on Soaps and Other Detergents which met in a two-day session in New York City, March 27 and 28. Several new specifications were approved for submission to letter ballot. The proposed McNicoll method for determination of rosin and the Wijs iodine method for fatty acids, together with a method on preparation of the fatty acids, were approved by the Subcommittee on Methods of Soap Testing. Procedures for testing dry cleaning detergents and methods of analysis were discussed in detail with considerable progress resulting. A method of determining CO_2 by evolution involving special detergents was approved and further activities involved phosphates and silicates.

The various sections working on specifications reported agreement on a number of matters. Proposed new specifications for both bar and chip palm oil soaps will be included in the committee's annual report and the drafting of standard specification requirements for soap powder and for built soaps was completed. New specifications for sodium metasilicate and trisodium phosphate in the field of special detergents were also reported favorably. An extremely difficult problem confronting the committee is that of satisfactory methods for evaluating detergency. This work is in the charge of the section on sulfonated detergents.

In the work involving metal cleaners there was consideration of proposed methods of analyzing these materials and a scheme for dividing metal cleaning processes into groups was discussed.

The meetings were under the general direction of H. P. Trevithick, New York Produce Exchange, *chairman*, and B. S. Van Zile, Colgate-Palmolive-Peet Co., *secretary*.

Since its organization in 1936, Committee D-12 has been extremely active and the many new recommendations which will be submitted to the Society at the forthcoming annual meeting indicate that there has been no diminution in its intensive work.

A Useful Convention for Calculating the Modulus of Elasticity and a Nomogram to Help in Computing the Elastic Modulus and the Flexural Strength

By I. L. Hopkins[1]

In routine testing of all sorts of plastics, we make a large number of determinations of flexural strength of standard A.S.T.M. $\frac{1}{2}$ by $\frac{1}{2}$ by 5 in. test bars, and at the same time often make deflection readings for modulus of elasticity determinations. The calculation of the modulus of elasticity involves the slope of the load-deflection curve of the specimen, and, as is well known, there can be difference of opinion as to the part of the curve which should be used. In order to test for conformity to requirements, and for reproducibility of results, personal judgment must be eliminated. We have, therefore, been obliged to adopt some convention as to the part of the curve which should be used, and have chosen the method given below. It will be noticed that we use only the middle of the curve, thereby eliminating the usually somewhat curved beginning and the often very much curved termination.

The readings for the modulus of elasticity in flexure are made upon the same specimen as the flexural strength test and at the same time. The deformation readings at the point of loading are taken by means of a dial gage graduated to 0.001 in. At least 10 simultaneous readings of load and deformation are made during the test without stopping the machine and are spaced in even increments of load over the entire range covered by the test. For computation of the modulus of elasticity, the load readings corresponding most nearly to 20 and 70 per cent of the maximum load are used, with their associated deflection readings. Using these values, the modulus of elasticity is computed according to the following formula:

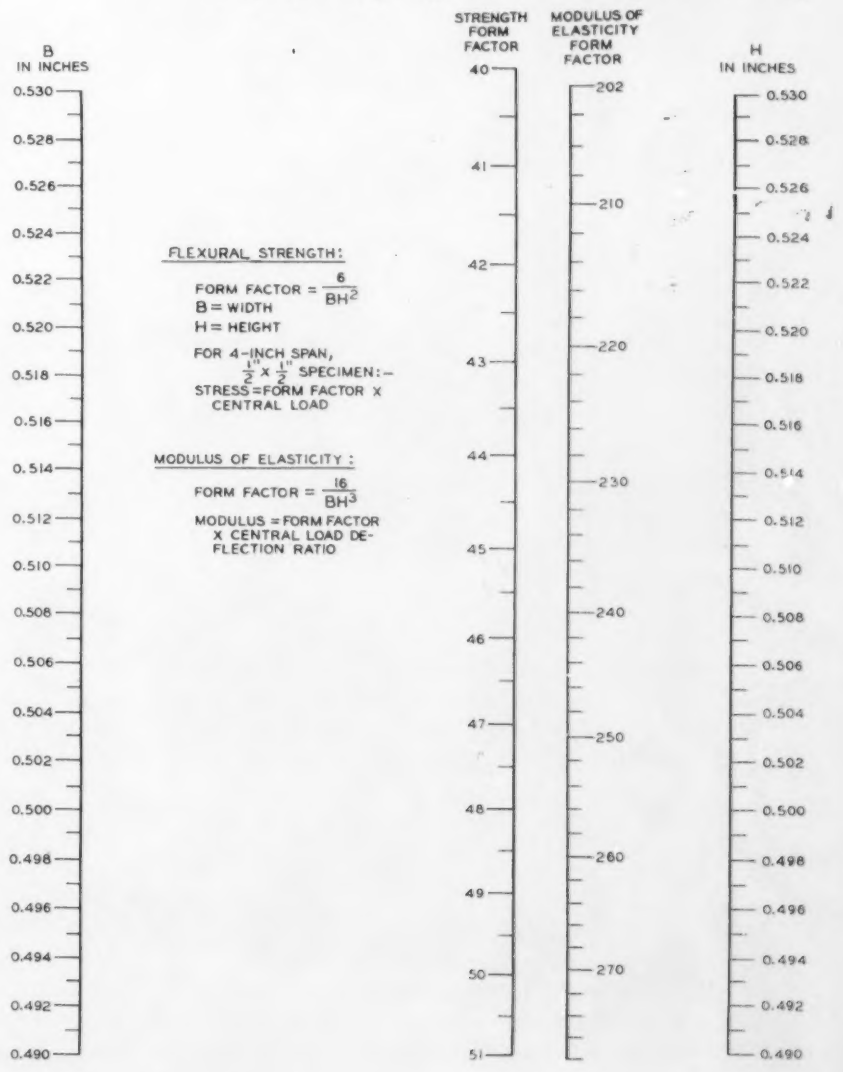
$$E = \frac{L^3 (W_{70} - W_{20})}{4BH^3 (D_{70} - D_{20})}$$

where L = length of specimen between supports in inches,
W_{70} = load reading at 70 per cent of maximum load in pounds,
W_{20} = load reading at 20 per cent of maximum load in pounds,
D_{70} = deflection associated with W_{70}, in inches, and
D_{20} = deflection associated with W_{20}, in inches.

The accompanying nomogram facilitates considerably the computation of the flexural strength and the modulus of elasticity. The mode of operation is illustrated by the following example: A bar with a width of 0.496 in. and a height of 0.522 in. was tested and the load-deflection readings are as given below:

Central Load, lb.	Central Deflection, in.	Central Load, lb.	Central Deflection, in.
2	0	130	0.084
10	0.006	140	0.094
20	0.012	150	0.103
30	0.017	160	0.110
40	0.023	170	0.120
50	0.030	180	0.130
60	0.036	190	0.141
70	0.042	200	0.154
80	0.049	210	0.169
90	0.055	220	0.184
100	0.063	230	0.210
110	0.069	240	0.230
120	0.077	250	0.262
		260 max. load	0.330

By laying a straightedge across the nomogram, connecting



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[1] Member of Technical Staff, Bell Telephone Laboratories, Inc., New York City.

$B = 0.496$ and $H = 0.522$, we obtain, at the intersection of the straightedge and the two inner scales, a strength form factor of 44.4, which multiplied by the 260 lb. maximum load gives a flexural strength of 11,500 psi.; and a modulus of elasticity form factor of 227 which is used in this formula

$$E = \frac{227\,(W_{70} - W_{20})}{D_{70} - D_{20}} = \frac{227\,(180 - 50)}{0.130 - 0.030} = 295{,}000 \text{ psi.}$$

This nomogram, as may be seen, combines the constant multipliers and the dimensions of the test specimen into factors, which are to be multiplied by the test figures, with a slide rule or otherwise, to yield the final results. A nomogram to take other sizes or lengths of specimen and to combine all operations was considered, but the simplicity of the present form was strongly in its favor, and the restriction of its range to the $\frac{1}{2}$ by $\frac{1}{2}$ by 5 in. bar resulted in open legible scales, which are very agreeable in constant use.

The First Testing Machine

IN his book "Materials Testing Machines," C. H. Gibbons[1] points out that probably the first testing machine, that is, the first in history that might be called a machine, was built by Pieter van Musschenbroeck,[2] Professor at the University of Leyden. This was built some time prior to 1729. Musschenbroeck would seem to have been curious about many things for some of the records of his tests on the strength of materials include data on the tensile strength of the "horn of an ox."

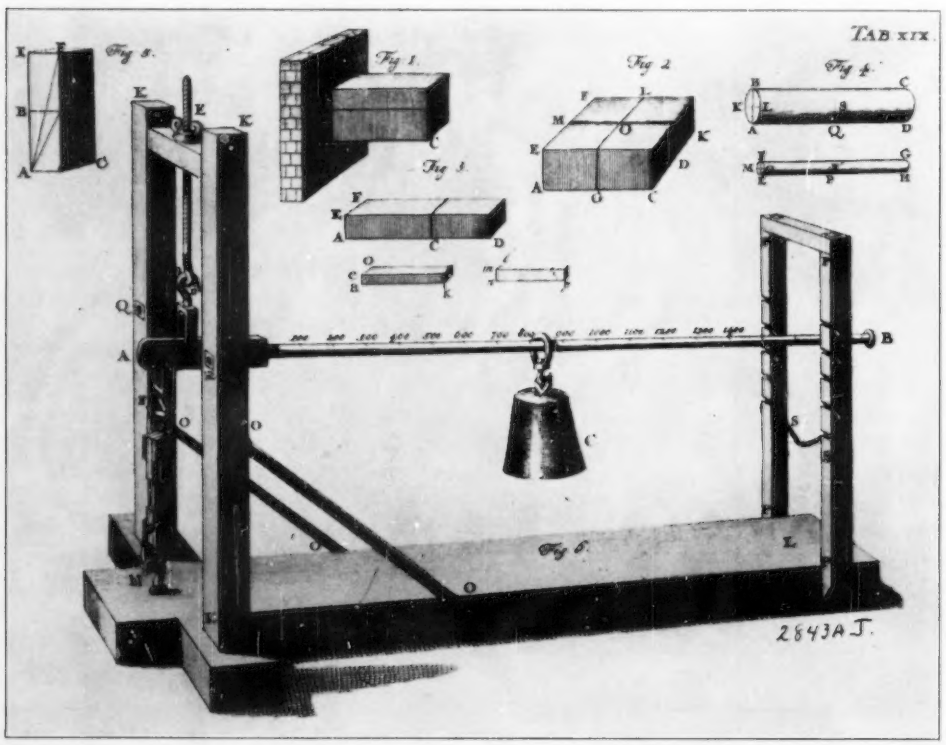
The testing machine which he built, shown in the accompanying illustration, consisted of a framework on which was mounted an ordinary steelyard. A movable weight provided the loading means. There was apparently no means for strain compensation (in order that the beam remain level throughout the test) but there was a means for compensation of variation in specimen lengths. His machine was small, and, therefore, his specimens were small, the metal ones being about 1/10 in. in diameter and the wood ones about 1/5 in. in diameter.[3] His investigations covered tension, bending, and compression of slender columns—all on a small scale—but with greater care and precision than had been previously attained.

This machine was built about 100 years after Galileo had carried out numerous tests on the strength of materials and it antedated by about a century the Franklin Institute's testing machine which is now at the Museum in Philadelphia and which is almost certainly the oldest testing machine in the world today, and one of the first, if not the very first, to be made in America.

[1] C. H. Gibbons, "Materials Testing Machines," Instruments Publishing Co., Pittsburgh, Pa. (1935).

[2] Musschenbroeck. Introductio ad Cohaerentiam Corporum Firmorum, 1729. Peter Barlow. The Strength of Materials, 1867, page 3.

[3] W. C. Unwin. *Proceedings*, Inst. Mech. Engrs. (British), October, 1918.



An Easy Job

AS nearly everyone knows, an executive has practically nothing to do. That is, except to decide what is to be done, to tell somebody to do it, to listen to reasons why it should be done, why it should be done by somebody else, or why it should be done in a different way, to prepare arguments in rebuttal that shall be convincing and conclusive: To follow up to see if the thing has been done: To discover that it hasn't: To inquire why: To listen to excuses from the person who should have done it: To follow up a second time to see if the thing has been done, only to discover—

That it has been done incorrectly, to point out how it should have been done, to conclude that as long as it has been done it may as well be left as it is, to wonder if it is not time to get rid of a person who cannot do a thing right, to reflect that the person at fault has a wife and seven kids, and that certainly—

No other executive would put up with him for another moment, and that in all probability any successor would be just as bad and maybe worse; to consider how much simpler and better the thing would have been done had he done it himself in the first place; to reflect sadly that if he had done it himself he would have been able to do it right in twenty minutes, but that as things turned out he himself spent two days trying to find out why it was that it had taken somebody else three weeks to do it wrong, and then realize that such an idea would strike at the very roots of the belief of all employees that "an executive has nothing to do!"

—The Kalends of the Waverly Press.

Control of Materials on a Large Building Operation

By Judson Vogdes[1]

In the control of quality of materials used on large-scale public works construction, a number of problems occur. These were successfully handled in the recent building program of the Philadelphia School District. The scope of this work was large, involving sixteen separate buildings costing $18,000,000. The construction was partly financed by Federal grant, thus being subject to additional rules and regulations, particularly regarding inspection of materials.

An organization was set up to handle the control of materials, divided into two parts: first, approval of samples, and, second, inspection and testing of materials delivered. The organization chart indicates the plan of operation used. The Board of Consultants consisted of three members: a Consulting Architect, chairman, a Consulting Structural Engineer, and a Consulting Mechanical and Electrical Engineer. This board had complete charge of the building program and played an important part in the approval of samples. The Public Works Administration was represented by a Chief Resident Engineer Inspector with a Resident Engineer Inspector on each building. Contact at the time of action on a sample was made with the Chief Resident Engineer Inspector who reviewed the action taken, which served as a guide to the inspector of the particular project.

An idea of the magnitude of the work involved may be had from the following statistics:

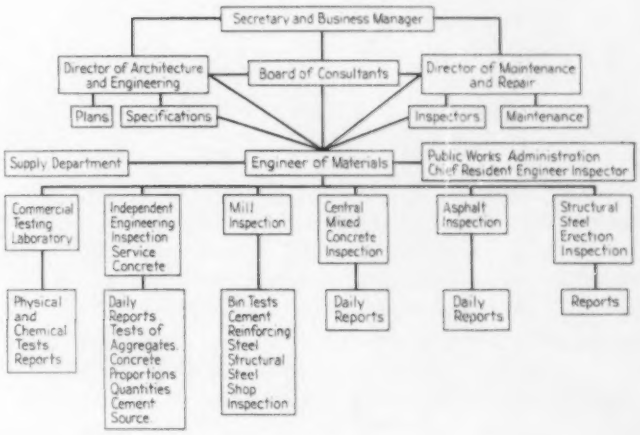
Total number of buildings	16
Total number of contracts	97
Total number of samples approved	4 080
Total yards of concrete	151 000
Total concrete test cylinders	1 950

In the case of five schools, the approval of equipment in addition to building materials was included in the work of this department. Here many of the items approved consisted of assemblies of materials, each item of which had to be considered.

The entire sixteen buildings were not under construction at one time. The largest number under contract at any one particular period was nine. Although the program was designed by a single organization, there were many differences in the requirements for each building. In some cases materials acceptable on one contract were not acceptable on another for various reasons. One of the problems was to keep accurate records of what was approved on a particular contract. Another was to be consistent on all contracts for any particular item. By centralizing the approval of samples, the human equation among field inspectors and possible differences of interpretation of the specifications was eliminated. Each contract had to be considered by itself even though the same material was being used by the same contractor on another building.

A system of forms was created with the idea of maintaining complete control of the materials and at the same time furnishing accurate and easily handled records. The procedure was briefly as follows: After signing a contract a list of samples and catalogue plates required was sent to the contractor. From time to time thereafter samples and catalogue plates in duplicate were submitted accompanied by a letter from the contractor. Submission by manufacturers and subcontractors was not acceptable until a letter from the contractor was received. Printed sample record cards and approval slips were filled in with pertinent information regarding the sample and attached thereto. After examination and possible test, action was taken by the Material Engineer. This consisted of certification that the item submitted conformed to the requirements of the specifications; otherwise a recommendation for its rejection was made.

ORGANIZATION CHART FOR MATERIAL DIVISION
SCHOOL DISTRICT OF PHILADELPHIA



In the case of acceptable material, the item was placed before the Chief of Architecture and Engineering who would then issue a letter of approval. Before notifying the contractor of the action, the matter was placed before the Board of Consultants and the Chief Resident Engineer Inspector who in turn each signed a special approval slip. These were in quadruplicate; one for the sample to the field, one for the Chief Resident Engineer Inspector, one for the Resident Engineer Inspector, and the original for our master file. A letter would then be written to the contractor, with copies distributed to all interested parties, approving the material. One sample or catalogue plate properly marked was then sent to the inspector in the field. In this way the field man was provided with an actual sample or catalogue plate showing what the contractor proposed to use and indicating that it had been approved for use on his building.

The use of forms greatly reduced the amount of clerical and stenographic help needed to carry on the work. About once a week the accumulation of items certified by the Material Engineer was reviewed by the Consultants and Chief Resident Engineer Inspector, requiring several hours' time each week. The work during the periods of peak activity was done by a staff consisting of one assistant engi-

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1]Engineer of Materials, School District of Philadelphia, Philadelphia, Pa.

FIGURE 1

Testing Agency

METALLURGICAL DEPARTMENT

District Works

Report of Chemical and Physical Tests of Date

Customer Shipping Notice

Shipped to Car Number

Customer Order No.	Mill Order No.	Heat No.	Section	Area	Yield Point, psi.	Tensile Strength, psi.	Elongation in 8 in., per cent	Reduction of Area, per cent	Bend Test	Analysis				Remarks
										C	Mn	P	S	

neer, two clerks, and one secretary. In addition to checking samples and maintaining control records, the same group was able to check and summarize the inspection and testing of materials delivered.

Field inspection of structural materials formed the second part of the work. The following materials were inspected either by our inspectors or by an approved inspection service: structural steel, portland cement, central mixed concrete, reinforcing steel, common brick, and bituminous concrete. In the case of central mixed concrete there was a field inspection by the Board's inspector consisting of making field test cylinders and slump tests.

Structural steel was inspected at the fabricating shop by our own inspector. It was his duty to obtain copies of mill tests, Fig. 1, for all rollings used in the work and forward them to our office. These were checked and filed. Daily reports similar to Fig. 2 were sent in showing the mark of the member, number required, number assembled to date, number riveted, number painted, and the number finally approved. To this was added the car number in which the member was shipped and the weight of the shipment. For each report the total weight previously reported shipped was given together with the weight of the report in question. Attached to the report was sent a copy of the fabricator's shipping notice giving additional information. By means of these reports we were not only able to be certain of material delivered to the job in accordance with the plans and specifications, but were also able at any time to know the progress of any part of the work. Under this method of control the progress of steel erection was speeded up and field corrections reduced to a minimum.

Portland cement was all tested at the bins and shipped in sealed cars to the central mixing plants and to the buildings for use in mortar. The large quantity of cement used for concrete and the fact that it was all mixed in three central mixing plants further complicated the problem of material control. The central mixing plants had limited bin capacity requiring a large number of bin tests on cement shipped, since only a part of a car might go on our work. When possible, bin tests were made 28 days in advance before shipment. Each car was sealed under the testing laboratory seal and was opened by our concrete inspector when unloaded to the plant bin. Cars shipped together with their seal number had to be checked against cars received and their seal numbers. Each car was checked to see that proper bin tests were on file. In this way all cement used for central mixed concrete was bin tested and followed through to the concrete mixer.

Central mixed concrete was furnished from three plants each with different cement bin capacity. Our specifications required that all central mixed concrete be certified as to mix and materials by an independent engineering inspection service. Two different engineers furnished this service. It was their duty to test the aggregates from time to time and to certify as to their compliance with the specifications and to report daily the results of the tests. Figure 3 shows a sample concrete report for the mixing plant. In addition to the usual tests of aggregates, surface-moisture determinations were made several times a day and wherever there was any apparent change in moisture content such as might occur when a new barge was starting to unload. By determining the contained water it was possible to approach the maximum water-cement ratio of the specification without exceeding the maximum allowed slump.

Reports for each class of concrete poured, including the proportion, total water used, slump, and quantity shipped, were furnished. These daily reports were checked and filed. A large part of the time we provided an inspector at the concrete plants who reported as in Fig. 3, to which report was added the certification by the independent engineer inspector. Each delivery ticket was certified as to the materials and mix.

Concrete delivered to each building was reported by our field inspector together with the slump. A copy of each delivery ticket was returned with the daily concrete report which indicated where the concrete was poured, the weather temperature, and what concrete cylinders were made. Cylinders were made by the testing laboratories in the presence

FIGURE 2

SCHOOL DISTRICT OF PHILADELPHIA
REPORT OF INSPECTION OF STRUCTURAL STEEL FABRICATION

Report No. Order No.

Name of Contractor Contractor No.

Location Date

For

Reported to

Req'd. Members Description	Number of Pieces					Car	Weights
	Req'd.	Asbld.	Riveted	Paintd	Ok'd.		

Shipped this week

Previously shipped

Total shipped Inspector

FIGURE 3

DAILY REPORT ON AGGREGATES AND CONCRETE

For: Board of Education Date

School

Contractor

Concrete Plant

Fine Aggregate	Total Percentages Passing Sieves											
	No. 4		No. 16		No. 50		No. 100		Fineness Modulus		Weight	

Coarse Aggregate	Total Percentages Passing Circular Openings										
	2¼	2	1¼	¾	⅝	½	⅜	¼	No. 10	Fineness Modulus	Weight
No. 1											
No. 2											
No. 3											

Cement Used	Brand	Car Number

Surface Moisture, per cent by weight												
	Time											
	Material											
	Per Cent											

Composition of Mixtures						
	Class					
	Cement, lb.					
	Fine Aggregate, lb.					
	Coarse Aggregate, lb.					
	Mixing Water					
	Surface Water					
	Total Water					
	Water Cement Ratio					
	Slump					
	Cubic Yards Shipped					
	Cement Used (bbls.)					

Remarks:

Inspector.

of the inspectors. The load of concrete from which the sample was obtained was noted and entered on the test report. After 24 to 48-hr. field curing, cylinders were removed to the laboratory for standard curing. Reports giving 7 and 28-day strengths were submitted together with all data pertaining to the concrete tested. By maintaining complete daily control of concrete in this way, it was possible to be certain of the quality and thus insure performance in the completed structure.

Large quantities of reinforcing steel were inspected both in the shop and in the field. Each shipment of reinforcing was accompanied by a mill test report. Specifications and the Building Code required the furnishing of shop tests in the case of rerolled steel together with an affidavit.

In addition, shop inspection was furnished in the case of some rerolled bars. Reports for each shipment were received giving details of bars included together with car number, weight, and test data. In this way it was possible to control the shipment of reinforcing steel to each building and to assure the receipt of material in accordance with the specifications.

In the inspection of brick and other masonry units, both field and plant inspections were used. In the case of material shipped in carloads it was possible to inspect it properly prior to actual use after delivery to the job. On the other hand, common brick delivered in truck loads would be used almost as fast as it was delivered which made it desirable to inspect it before shipment from the plant. Previous tests had shown that for a particular plant and process of manufacture the modulus of rupture and density were directly related to the compressive strength according to which properties, the brick were specified. Accordingly, our plant inspector made periodic tests of all brick produced, designating which might be shipped to our buildings. In this way we were able to insure delivery of acceptable brick which was substantiated by compression tests made from deliveries to the field. Figure 4 shows the form of report used for common brick.

Although the quantity of bituminous concrete used was not great, it was widely distributed throughout the work. Figure 5 shows the form of report used for asphalt inspection. Since a certain amount of flexibility is necessary in the selection of the mix for the work, the form used was desirable. Here the aggregate and asphalt were approved as materials and samples furnished to the inspector.

The carrying out of such a program required considerable testing. Special testing devices had to be constructed to test properly some assemblies of materials such as Fig. 6. In some cases samples were tested, particularly where there were performance requirements in the specifications. In the case of paints, asphalts, and similar materials, the manufacturer was required to furnish a test report either by an independent laboratory or one signed by his chemist giving the properties of the material in accordance with the specification requirements. Wherever possible American Society for Testing Materials or Federal specifications had been used in preparing the specifications for this phase of the work. Approval was given on receipt of a proper test report indicating that the material conformed to the requirements of the specification, subject to field tests. Tests were later made at our discretion by an independent laboratory from samples of the material delivered. In this way complete control of such materials was effected. While we did not maintain a complete testing laboratory, the material department performed such inspection as weighing, measuring, visual inspection, comparison for texture color and appearance.

In approving samples and catalogue plates, duplicate samples properly marked and indexed with numbers were filed so as to be easily accessible. These samples were constantly referred to by the design department and ourselves when acting on similar materials for other projects. These office copies of samples are filed and serve many useful services during the life of the buildings.

The system set up to handle samples and control materials is particularly adapted to an organization such as ours which not only constructs the buildings but must maintain them at a minimum cost for years to come. Experience has

FIGURE 4

DAILY REPORT—SAND LIME BRICK INSPECTION
SCHOOL DISTRICT OF PHILADELPHIA

School_____ Shipped_____ Date_____

_____ Shipped_____

Plant_____

Weather_____

Car	Cylinder No. 1		Cylinder No. 2		Cylinder No. 3	
	b*	W*	b	W	b	W
	d*	M.R.*	d	M.R.	d	M.R.
No. 1						
No. 2						
No. 3						

_____ Inspector.

* b = breadth, d = depth, W = breaking load, M.R. = Modulus of rupture.

shown that the smallest detail in construction of the building may in later years affect the permanency of many other materials costing many times as much. The details of this system, however, are sufficiently flexible to be adapted to small projects such as our maintenance jobs where they have been equally successful. Where a manufacturer produces a number of products, only one of which meets the requirements of the specifications, it is important to obtain

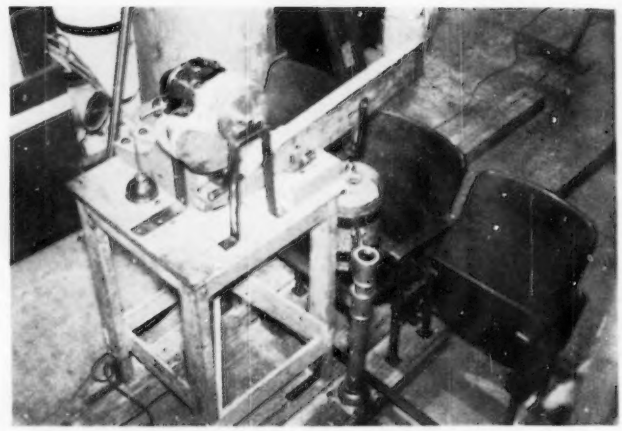


FIG. 6.—Device for Testing Resistance of Auditorium Chair Seats to Repeated Impact of 40-lb. Sand Bag. Test Required Chair to Withstand 20 000 Blows at 18 Per Minute.

the one specified. The problem of controlling materials is much simplified where the specifications refer to accepted performance requirements as are found in standard and tentative specifications of the A.S.T.M. and the Federal Government.

The methods described for control of materials, both in approval of samples and inspection of deliveries, have demonstrated their worth by obtaining the use of materials conforming to the specifications. Much of the success of this work can be traced to the use of adequate forms and a routine of considering each item entirely on the requirements of the specifications in question.

FIGURE 5

ASPHALT PLANT AND PAVING REPORT

Date_____

Temperature_____

Contractor_____ School_____ Area Paved, sq. yds._____ Weather_____

Plant_____ Type Pavement_____ Asphalt Used_____ Type Aggregate_____

Condition Screens at Plant_____ Were Mixer Teeth in Good Condition_____

Type Foundation_____ Condition Subgrade_____ Did Weak Spots Appear in Base_____

Type and Condition of Roller_____ Appearance After Rolling_____

	Binder	Top
Number tons laid		
Yield, sq. yd. per ton		
Weights per square yard, lb.		

Per Cent of Materials Listed		
	Binder	Top
Coarse Stone		
Fine Stone		
Screenings		
Filler		
Bitumen		
Naphtha		
Lime		

SCREEN ANALYSIS OF AGGREGATES

	2 in.	1 ½ in.	1 ¼ in.	¾ in.	⅝ in.	½ in.	⅜ in.	¼ in.	⅛ in.	No. 10	No. 40	No. 80	No. 100	No. 200			
Binder																	
Specifications																	
Filler																	
Specifications																	

Remarks_____ Plant Inspector_____

_____ Yard Inspector_____

Architects Sponsor Plastering Committee

In an article in the March BULLETIN, page 33, announcing the new specifications for gypsum plastering and lathing which were developed by Sectional Committee A42 under the procedure of the American Standards Association, the sponsors of the committee were indicatd as A.S.T.M. and the American Concrete Institute. Of course, this was in error, since the American Institute of Architects cooperates with the Society in sponsoring this sectional committee. The A.I.A. representatives on the committee are the chairman, W. R. McCornack, School of Architecture, Massachusetts Institute of Technology, and T. I. Coe, Technical Secretary, Structural Service Dept., A.I.A. The A.S.T.M. is represented by J. C. Pearson, H. J. Schweim, Stanton Walker, F. C. Welch, and L. S. Wells.

List of American Standards and Safety Codes

Copies of the new annual list of American Standards and Safety Codes have recently become available. The list includes some 400 nationally approved standards, safety codes, and specifications indexed alphabetically and also industrially according to subject. These cover work in the fields of civil engineering, mechanical engineering, electrical engineering, automobile and aircraft, transportation, ferrous metallurgy, non-ferrous metallurgy, chemical industry, textiles, mining, wood, paper and pulp, petroleum products, symbols and abbreviations, etc. The list may be obtained without charge by writing to the American Standards Association, 29 W. Thirty-ninth St., New York City.

Highway Research Board Publications

Announcement has been made by the Highway Research Board of the National Research Council, 2101 Constitution Ave., Washington, D. C., of various publications which are in the course of completion, including Parts I and II of the Proceedings of the Eighteenth Annual Meeting of the Board. Part I includes the various papers and articles dealing with finance, economics, design, materials and construction, maintenance, traffic and safety, soils; while Part II includes the papers on soil testing, soil mechanics, fill compaction, stabilization, subgrades and soil tests. Each part of the Proceedings is available at $2.25. In addition, Reports by the Joint Roadside Development Committee can be obtained at 50 cents per copy in mimeographed form and the Discussion on Rural Traffic Problems also in mimeographed form is listed at 50 cents. Orders for these publications should be sent to the Highway Research Board.

Physical Constants of Hydrocarbons

There has recently been issued by The Texas Company, New York City, an extensive volume entitled "Physical Constants of the Principal Hydrocarbons." The data were compiled by M. P. Doss of the Technical and Research Division. Most of the aliphatic hydrocarbons so far isolated or synthesized are included and this is somewhat true for the naphthenes, cyclohexenes, etc., as well as the mononuclear aromatics. Only the principal members of the polycyclic series are given, mainly those isolated from petroleum residues. An extensive bibliography has been included giving references to many of the sources from which essential information has been developed.

Correction in Clay Sewer Pipe Revision

Attention is called to a typographical error in the proposed revision of the Standard Specifications for Clay Sewer Pipe (C 13 – 35). In the revised table of physical test requirements the average crushing strength by the sand bearing method for pipe 24 in. in internal diameter is indicated to be changed from 3070 lb. per linear foot to 3125 lb. per linear foot. This latter value should be 3425 lb. per linear foot. Members should note this correction in the table which appears in the *Proceedings* Vol. 38, Part I, p. 1321 (1938); also 1938 Book of A.S.T.M. Tentative Standards, p. 1687.

Principles of Electro-Chemistry

"The Principles of Electro-Chemistry" recently published by the Reinhold Publishing Corp., 330 W. Forty-second St., New York City, is a volume by D. A. MacInnes, of The Rockefeller Institute for Medical Research. This book furnishes primarily an account of theoretical electro-chemistry as it is today. The 478-page volume covers various laws, theories of dissociation, electrolytic transference, principles of thermodynamics, and many other important topics and problems with which this field is concerned. The determination and meaning of "pH" values are described, potentiometric titrations, etc. There is a detailed author and subject index. Copies of the publication can be obtained from the publishers at $6 each in cloth binding.

Proceedings of Rubber Technology Conference

The Proceedings of the Rubber Technology Conference held in May, 1938, under the auspices of the Institution of the Rubber Industry, London, England, have recently been issued. This very extensive volume, comprising over 1150 pages, was edited by T. R. Dawson and J. R. Scott affiliated with the Research Association of British Rubber Manufacturers. Obviously, it is impossible here to present a clear conception of all the subjects covered in this volume, but the main topics include plantation subjects, two sessions on latex, two on chemistry, one on general technology, one on synthetic rubber-like materials, another on compound materials, four on durability, two on physics, and two sessions on applications. There were over one hundred technical papers presented by world authorities.

Copies of the publication can be obtained from the Institution of the Rubber Industry, 12 Whitehall, London, S. W. 1, England, at £2, 2s per copy.

1939

JUNE

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25	26	27	28	29	30	

ASTM BULLETIN

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AMERICAN SOCIETY FOR TESTING MATERIALS

No. 98 — May, 1939

Youth in the Society

MUCH has been made of the importance in any continuing organization of maintaining a live interest on the part of the young men who in years to come must take over the reins. In A.S.T.M. there have been a reasonable number of younger technical men participating in activities, both in the meeting programs and in committee work, and in recent years an increasing number of the younger type of technical executives are becoming active. Perhaps the main reason lies in the fact that quite a few of the newer industries have realized the importance of standardization and research on properties of materials and testing and naturally enough in these fields the engineers and associated personnel would be in the younger brackets.

Nevertheless, every opportunity should be used to stimulate interest on the part of the younger men and also to develop a better understanding on the part of those who are not the so-called "top technical executives" but who may be in charge of routine testing or some phase of a research plan —the men who are responsible for the technical control at a research plant, etc. Too often, the technical man has a copy of a printed A.S.T.M. document and uses it daily—his bible, so to speak—but doesn't know what is behind it.

The annual, regional and local meetings and often committee meetings provide a good chance for these men, no matter what their age, to become acquainted with the Society, how it works and to realize some of its benefits.

This year, an outstanding opportunity is available at the annual meeting for the younger engineer and the technical man in the plant to attend the meeting and to associate with the technical leaders. At the many symposiums and round-table discussions especially, they can get into the thick of affairs—participate in the exchange of ideas, meet other men concerned with similar problems.

Members will be rendering a distinct service to the Society and to their profession if they will acquaint their associates with the meeting and either persuade or arrange for some of those most interested to attend the annual meeting for a day or even for a session or two. (This year there will be several evening sessions in case any of the men cannot get to the meeting during the day.)

In advising younger technical graduates on ways and means of getting ahead, the editorial director of an outstanding magazine some months ago mentioned that no matter how good a man may be, others have to rub elbows with him before they appreciate it, and while he might not be able to play golf with those he would like to meet, he can with warm welcome join some of the technical societies and attend these meetings. Local, regional, and national meetings are available for contact purpose. This editor pointed out that one joins a technical society for its usefulness in his career and that it can be useful in other than technical ways. If one is willing to work and do it modestly, even though he does it for a self-seeking purpose, the work may well be rewarded in the long run.

Writing Concisely—A Forgotten Art?

SOMEONE has said that by reading a few pages of a technical paper or report prepared by an engineer, he can evaluate fairly closely the caliber of the writer. While this may be somewhat exaggerated, since there are a number of able technologists who do not possess the faculty to write clearly and concisely, nevertheless, usually one of the products of clear thinking is clear and concise exposition. A well organized paper, phrased so as to give the exact meaning intended, with all non-essentials eliminated, is many times more effective than one loosely written that includes many details not essential to a clear understanding of the points at issue.

It is surprising how much blue-penciling an editor can do and how much condensation can be effected and still retain everything of importance in the paper. It is not a question of saving space, but of enabling the reader to grasp the subject readily, upon which he is more inclined to accord the paper the importance it deserves.

A poorly written paper, on the other hand, no matter how valuable the data contained may be, usually creates an unfavorable impression and is passed over—possibly not even completely read.

Most technical men—in fact, all professional men—find it impossible to digest as much as they would like of published material and their time must be conserved. All technical writers should review their manuscripts critically to insure that the material will not be ignored because of verbosity or lack of clarity.

A More Valuable Bulletin

IN considering progress made in expanding the ASTM BULLETIN to include more technical material, it is interesting to compare the issues of the past year or two with those of six or eight years ago. When one considers that the total pages of text published in the six 1939 issues was 254 and in the period from 1930 to 1933 the average was 70, the great growth in the BULLETIN is rather startling.

It all started about two years ago when the Committee on Papers and Publications recommended a larger BULLETIN, gradually expanded to include more technical papers, informal and interim reports and related material as a benefit to the members. Numerous comments received bear out the

wisdom of this decision. The much larger publication with more news and contributed material, is proof that there was no paucity of available material. The publication will continue to grow.

In 1938 there was an average of about five papers in each of the six issues—papers which were of definite value and of timely interest. Sometimes, the decision on whether a paper should be published in the *Proceedings* or BULLETIN is difficult to make. Basically, it depends on the extent to which the technical contribution may be considered to have reference value, because the material for the *Proceedings* should be of this class. Nevertheless, much of the information included in many of the BULLETIN papers has also a considerable degree of permanent value.

Some thought is being given to the question of how members can most conveniently file their BULLETINS. An effort is regularly made in paging the issues, to have papers and reports and other articles which members may wish to retain, starting on a right-hand page so that the material can be taken out, fastened together and filed in folders. Many of the members have such filing systems. A binder for the complete issues is also a possibility.

With this May, 1939, issue is enclosed a subscription card with the thought that some members may wish to order extra copies (each member, of course, receives it regularly) or the card can be used in case a member's associates may wish to subscribe to this publication and keep in touch with vital work in the field of material standardization and research.

Members of committees who are not affiliated with the Society through membership should find subscription to the BULLETIN an excellent way of keeping currently informed on Society affairs.

Preprints and Discussion

ATTENTION is directed (see page 2 of this issue) to the continuation of the procedure in effect for many years by which each member of the Society may secure without charge a preprint copy of the papers and reports to be presented at the annual meeting. This procedure has been in effect so long that many are likely to overlook its primary purpose namely, the stimulation of constructive discussion.

In the case of committee reports, it is essential that the recommendations with respect to standards be understood by those who will vote at the annual meeting sessions and subsequently by letter ballot. Suggestions for revisions may be offered. In the case of papers the need for discussion prompts the practice.

It is virtually impossible to preprint all of the papers since in some cases manuscripts are not available sufficiently early, but it is not an unusual year to have 80 per cent or more of the reports and papers in type and distributed to members and to those who have been suggested as discussors. When manuscripts are not received in time for preprinting, an abstract of the paper is made available.

Why so much effort expended to secure discussion? First of all, it is a safety valve. Facts may have been misinterpreted or some important consideration ignored. While sometimes of a critical nature, discussion is not necessarily so. Frequently, additional information is presented to prove even more definitely the conclusions reached by the author. From the standpoint of interest in a meeting or session, discussion is quite essential. Anyone who has attended a session where a series of papers has been presented and accepted in a matter of fact manner knows full well how "flat" the meeting can be. It is for this very reason that authors are asked to make a concise presentation of their papers, so as to allow time for discussion.

It is most interesting, on examining the Society's *Proceedings* or one of its technical publications, to find what a considerable portion of the volume is devoted to discussion. Without this, much of great value and significance would be lost.

At all meetings of the Society written and oral discussion is welcomed, either to bring out some obscure point, or for publication as additional material which, of course, will depend on its intrinsic value. The discussion may be of even more value than the paper itself. Those who cannot attend meetings may thus miss a great deal by not hearing discussion.

Nominations for Officers

THE Nominating Committee to select nominees for Society officers met in Columbus on March 9. The personnel of this group was listed in the March BULLETIN. In accordance with the provisions of the By-laws of the Society, the following nominations are announced:

For President:

H. H. MORGAN, Manager, Rail and Fastenings Dept., Robert W. Hunt Co., Chicago, Ill.

For Vice-President:

G. E. F. LUNDELL, Chief, Chemistry Division, National Bureau of Standards, Washington, D. C.

For Members of Executive Committee:

J. J. ALLEN, Chief Chemist, Mechanical Rubber Goods Div., The Firestone Tire and Rubber Co., Akron, Ohio.

R. D. BONNEY, Assistant Manager of Manufacturing, Congoleum-Nairn, Inc., Kearny, N. J.

T. S. FULLER, Engineer of Materials, Works Laboratory, General Electric Co., Schenectady, N. Y.

J. L. MCCLOUD, Metallurgical Chemist, Ford Motor Co., Dearborn, Mich.

M. A. SWAYZE, Chief Research Engineer, Lone Star Cement Corp., Hudson, N. Y.

Each of the above nominees has indicated in writing his acceptance of his nomination. The By-laws provide that "further nominations, signed by at least 25 members, may be submitted to the Secretary-Treasurer in writing by May 25, and a nomination so made, if accepted by the member nominated, shall be placed on the official ballot" which "shall be issued to the members between May 25 and June 1."

H. J. Ball Appointed to the Executive Committee

MR. G. E. HOPKINS, due to his leaving his position as Technical Director, Bigelow-Sanford Carpet Co., Inc., Thompsonville, Conn., to become affiliated with the United Shoe Machinery Corp., Beverly, Mass., felt impelled to resign from the Executive Committee. This resignation has been accepted with regret by the Executive Committee, which took action to appoint H. J. Ball, Professor of Textile Engineering, Lowell Textile Institute, Lowell, Mass., to fill the vacancy. Professor Ball, who served a term as a member of the Executive Committee from 1934 to 1936, has been chairman of Committee D-13 on Textile Materials since 1930. Mr. Hopkins' term of office would have expired in 1940 so that Professor Ball will serve until that time.

XXII. Long-Time Society Committee Members

Twenty-second in the Series of Notes on Long-Time Members

As a continuation of the series of articles in the ASTM BULLETIN comprising notes on the outstanding activities of long-time A.S.T.M. members, there are presented below outlines of the work of three additional members. In general the men whose activities are described in this series have been affiliated with the Society for 25 years or more and have taken part in committee work for long periods of time. No definite sequence is being followed in these articles.

J. O. LEECH, Assistant Manager, Metallurgical Division, Pittsburgh District, Carnegie-Illinois Steel Corp., has been connected with the Carnegie organization since 1890, when he was first employed in the Inspection Department of Carnegie-Phipps and Co. Following an extended period of service in the Inspection Department, he was appointed manager of the Bureau of Inspection and Tests, Carnegie Steel Co., and later was Assistant Metallurgical Engineer. He has been in his present position since the reorganization of the Carnegie-Illinois Steel Corp.

A personal member of the Society since 1911, Mr. Leech has been extremely active in a number of phases of committee

L. S. Moisseiff Louis Anderson J. O. Leech

and related work, particularly in the steel field. Affiliated with Committee A-1 on Steel since 1912, he is a member of several of its subcommittees, on two of which, Subcommittee II on Structural Steel and Subcommittee XI on Boiler Steel, he has held membership continuously for over 25 years. He is also a member of the Advisory Committee of Committee A-1 on Steel and is a representative of his company on Committee A-5 on Corrosion of Iron and Steel. Mr. Leech served as a member of the A.S.T.M. Executive Committee from 1932 to 1934 and has been a member of Committee E-10 on Standards since 1934.

It frequently happens that services which a member renders to the Society may not be evident on the surface or to those who are not in intimate contact with many of its problems. This is especially true in the case of Mr. Leech, one of whose outstanding services has been in connection with the editorial makeup of a large number of the steel specifications. He is vitally concerned with the subject of correct nomenclature in the steel industry and his office library in Pittsburgh is evidence of the interest in this field—reference books, etc., abound. Mr. Leech assisted in the preparation of Tiemann's Pocket Encyclopedia on Iron and Steel, particularly the section on specifications.

Since 1918 Mr. Leech has been Secretary-Treasurer of the Association of American Steel Manufacturers Technical Committees, the A.S.T.M. membership of which he also represents. His valuable accomplishments in promoting the use of standards in the steel industry are noteworthy. He is also active in the work of the American Iron and Steel Institute's Technical Committee and is one of the Institute's representatives on the Standards Council of the American Standards Association. A member of the Materials Subcommittee of the A.S.M.E. Boiler Code Committee, he devotes considerable time and energy to this important activity.

He has been a member of the A.S.T.M. Pittsburgh District Committee since its organization in 1932 and has done much to promote the interests of the Society in the Pittsburgh area.

LOUIS ANDERSON, Chemical Engineer, Alpha Portland Cement Co., Easton, Pa., has been connected with that company since 1904, in which year he was graduated from Lafayette College with the degree of B.S. in Chemistry. He was successively Second Assistant Chemist, First Assistant Chemist, and in 1905 became Chemist in Charge, holding this position until 1911, when he became Combustion Engineer in Charge of Kiln and Boiler Efficiency at all of the company's plants. In 1915 he became Technical Adviser to the Sales Department, and in July, 1919, he was made Chief Chemist and Chemical Engineer responsible for the quality of the cement manufactured at all ten plants of the Alpha Portland Cement Co., which position he still holds. Since 1911 his headquarters have been at the main office of the company in Easton.

A personal member of the Society since 1913, he has been active in various phases of its work, particularly in connection with Committee C-1 on Cement, of which he has been a member since 1919. He represents the cement committee on Committee E-1 on Methods of Testing, serving on a number of its subcommittees and sections. He served as a member of the Society's Executive Committee from 1925 to 1927. In addition to his A.S.T.M. membership, he is a member of the American Institute of Chemical Engineers, American Chemical Society, American Concrete Institute, Engineers' Club of the Lehigh Valley and the Technical Problems Committee of the Portland Cement Assn., which acts as an advisory committee for the Research Laboratory of that Association. He is also a member of the Abraham Lincoln Association of Springfield, Ill.

Mr. Anderson holds patents on a continuous automatic sampling apparatus for sampling powdered materials, which apparatus is used to a large extent in the cement industry.

LEON S. MOISSEIFF, Consulting Engineer, New York City, following his graduation from Columbia University in 1895 in civil engineering, was Engineer of Design, Department of Bridges, New York City. During the period 1897 through 1915, the Queensborough, Manhattan and the strengthening of the Williamsburg Bridges were outstanding problems. He was Engineer of Design for the Philadelphia-Camden Bridge, 1920 to 1926 and has been consulting engineer on many of the country's other outstanding structures, including the George Washington and Bayonne Bridges, New York; Ambassador Bridge, Detroit; Triborough and East River Bridges, New York; Tacoma Narrows Bridge,

Washington; and the Mackinac Straits Bridge; also the Bronx-Whitestone Bridge, the latter being in course of construction. Mr. Moisseiff was a member of the Board of Engineers for the Golden Gate Bridge and also the San Francisco-Oakland Bridge.

His membership in the Society dates from 1903. In that year Committee C-2 on Reinforced Concrete was organized, Mr. Moisseiff serving continually until the committee was discharged in 1932. He is a member of Committee A-1 on Steel, being interested primarily in Subcommittee II on Structural Steel for Bridges, Buildings and Rolling Stock, and he has served for many years as one of the Society's representatives on the Joint Committee on Concrete and Reinforced Concrete, at present being chairman of its Subcommittee on Metal Reinforcement.

In 1913, Mr. Moisseiff was honored by being awarded the Franklin Institute Gold Medal for his work on the Bayonne Arch and the Norman Gold Medal of the American Society of Civil Engineers in connection with his activities on the design and construction of the George Washington Bridge. He is a member of numerous other societies and groups, including the following: American Society of Civil Engineers, American Railway Engineering Assn., American Welding Society. Mr. Moisseiff has presented a number of technical papers before various societies and some have been published in the A.S.T.M. *Proceedings*, including one in 1930 entitled "Investigation of Cold-Drawn Bridge Wire."

Phillips Petroleum and General Electric New Sustaining Members

IN the March BULLETIN there was announced a list of six new sustaining members who had subscribed to this class of membership recently, bringing the total number of these members to eighteen.

Since then two other companies have been added to this list, the Phillips Petroleum Co., Bartlesville, Okla., represented by Mr. G. G. Oberfell, Vice-President, and the General Electric Co., Schenectady, N. Y., represented by Mr. T. S. Fuller, Engineer of Materials.

Both of these organizations have been connected with the work of the Society for many years. Mr. Oberfell has been a member since 1921 and has been active in many phases of committee work, particularly in D-2 on Petroleum Products and Lubricants.

The General Electric Co. at Schenectady has been affiliated as company members since 1908, formerly represented by Mr. J. A. Capp. Mr. Fuller has been company representative since Mr. Capp's death and also is a personal member. He is very active in many phases of the work of the Society. He has been Chairman of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys, a member for a number of years of the Research Committee on Fatigue of Metals, and represents the General Electric Co. on more than twenty standing committees. He has been nominated as a member of the Executive Committee.

This class of membership was instituted several years ago so that organizations who found it appropriate might contribute to the support of the Society's work to an extent somewhat more nearly commensurate with the real value of A.S.T.M. activities to them. Further information concerning this class of membership will be gladly given upon request to A.S.T.M. Headquarters.

PERSONALS

News items concerning the activities of our members will be welcomed for inclusion in this column.

V. H. LAWRENCE, formerly Metallurgical Engineer, Alan Wood Steel Co., Conshohocken, Pa., is now Assistant to Vice-President, for the same company.

WILLIAM KRUMBHAAR, who was connected with Beck, Koller and Co., Inc., Detroit, Mich., as Research Chemist, is now Vice-President, In Charge of Technical Development, Reichhold Chemicals, Inc., Brooklyn, N. Y.

J. C. WITT is now connected with The Marquette Cement Manufacturing Co., as Technical Service Manager. He was formerly Manager, Research and Development, Universal Atlas Cement Co.

E. H. DIX, JR., Chief Metallurgist, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa., has been selected to present the 1940 Institute of Metals Lecture of the American Institute of Mining and Metallurgical Engineering at the annual meeting of the A.I.M.E. in February, 1940.

E. T. NETTLETON, formerly Western Sales Manager, New Haven Trap Rock Co., New Haven, Conn., is now Secretary and Engineering Director, New York State Crushed Stone Assn., Inc., Albany, N. Y.

G. H. WOODROFFE is now Manager, Inspection and Field Service, Baldwin Locomotive Works, Philadelphia, Pa.

I. M. BREGOWSKY, formerly Manager, Grabler Manufacturing Co., Chicago, Ill., is now retired and living on the West Coast in San Diego, Calif. He has been a member of the Society since 1904.

H. S. FALK, Vice-President and Works Manager, The Falk Corp., Milwaukee, Wis., will receive the John A. Penton Gold Medal at the forty-third annual convention of the American Foundrymen's Assn., May 15 to 18, in recognition of his leadership in promoting interest in foundry apprentice training.

H. S. MATTIMORE, Engineer of Materials, Pennsylvania State Highway Dept., Harrisburg, Pa., is the new president of the Harrisburg chapter of the Pennsylvania Society of Professional Engineers.

R. C. GRIFFIN, Treasurer, Arthur D. Little, Inc., Cambridge, Mass., was elected to the executive committee of the Technical Association of the Pulp and Paper Industry at the annual meeting of the association held in February.

E. M. HASTINGS, Chief Engineer, Richmond, Fredericksburg & Potomac Railroad Co., Richmond, Va., was elected president of the American Railway Engineering Assn. at their Fortieth Annual Meeting in Chicago, held in March.

At the recent meeting of the American Concrete Institute, F. E. RICHART, Research Professor of Engineering Materials, University of Illinois, Urbana, Ill., was elected president; R. B. YOUNG, Testing Engineer, Hydro-Electric Power Commission of Ontario, Toronto, Canada, senior vice-president; and R. W. CRUM, Director, Highway Research Board, National Research Council, Washington, D. C., director.

Catalogs and Literature Received

GEORGE SCHERR CO., 128 Lafayette St., New York City. A new general catalog showing the complete line of machine tools, instruments and machinery handled by this company. The catalog includes mechanics' tools, optical inspection tools, gear testing equipment, machinery for instrument making, such as automatic turning lathes, pivot burnishing machines, speed indicators, etc. Included also are several items that are being shown in the United States for the first time, among these being a bore inspection telescope for inspecting interior surfaces of tubes, pipes, etc., in order to reveal any defects.

TINIUS OLSEN TESTING MACHINE CO., 500 North 12th St., Philadelphia, Pa. Bulletin No. 18. A twelve-page folder describing the electronic high magnification stress-strain recorder, and telling how Olsen has brought this recorder within the scope of routine testing. Illustrated, including diagrams of test results.

E. H. SARGENT & CO., 155-165 E. Superior St., Chicago, Ill. A well designed and profusely illustrated publication on polarographic analysis employing the Heyrovsky Micro Polarograph used for rapid quantitative and qualitative analysis by automatic recording of current voltage curves. With this catalog is a bibliography on "Polarography" giving a complete list of literature published in this field from 1922 to 1938 (24 pages). The catalog in a special cover comprises some 32 pages and includes useful tables.

WILL CORP., Rochester, N. Y. Catalog 5 covering Laboratory Apparatus for Chemical, Biological, Metallurgical and Clinical Laboratories. 920-page volume in stiff board covers. A large number of items are covered in alphabetical sequence with an alphabetical index at the top of each page. Supplementing this is a comprehensive subject index of 34 pages including a separate three-page A.S.T.M. index. Profusely illustrated.

NEW MEMBERS TO APRIL 20, 1939

The following 38 members were elected from March 9 to April 20, making the total membership 4180:

Company Members (10)

ALUMINUM AND MAGNESIUM, INC., J. G. G. Frost, President, Huron St. and Sandusky Bay, Sandusky, Ohio.

AMPCO METAL, INC., W. W. Edens, Metallurgist, 3830 W. Burnham St., Milwaukee, Wis.

CAMPBELL TAGGART RESEARCH CORP., C. J. Patterson, President, 4049 Pennsylvania Ave., Kansas City, Mo.

CHASE BAG CO., R. C. Walsh, Advertising Manager, E. Fortieth and Perkins Aves., Cleveland, Ohio.

DELCO PRODUCTS DIVISION, GENERAL MOTORS CORP., G. V. Pickwell, Spring Engineer, 329 E. First St., Dayton, Ohio.

KROUT & FITE MANUFACTURING CO., J. E. Fite, Jr., Secretary, 1952 E. Allegheny Ave., Philadelphia, Pa.

MOUNTAIN STATE STEEL FOUNDRIES, H. F. Stratton, President, Box 1039, Parkersburg, W. Va.

PATTERSON FOUNDRY AND MACHINE CO., THE, D. M. Wilhelm, Secretary, East Liverpool, Ohio.

RUBICON CO., Josef Doerr, President, 29 N. Sixth St., Philadelphia, Pa.

THOMAS STEEL CO., THE, Delaware Ave., Warren, Ohio.

Individual and Other Members (28)

ALFERY, H. F., Chief Engineer, Milwaukee Gas Specialty Co., 2025 W. Clybourn St., Milwaukee, Wis.

BEYER, V. F., Technical Manufacturing and Sales Representative, Stanco, Inc., Box 216, Elizabeth, N. J.

BYE, ELMER, Metallurgist, Simonds Saw and Steel Co., Lockport, N. Y.

CAMP, W. M., Head of Research, The Clark Thread Co., 260 Ogden St., Newark, N. J.

DEMAREST, W. G., President, New Jersey Hollow Tile Corp., 1328 Broadway, New York City.

DOLAN, T. J., Assistant Professor of Theoretical and Applied Mechanics, University of Illinois, 311 Materials Testing Laboratory, Urbana, Ill.

DONLAN, T. R., Chemist in Charge, Solvents Development Laboratory, Standard Alcohol Co., Bayway Refinery, Elizabeth, N. J.

FARMER, A. D., City Chemist, Municipal Building, Norfolk, Va.

FRIEDMAN, ARTHUR, President, The Chemical Rubber Co., 1900 W. 112th St., Cleveland, Ohio.

GROTTS, FRED, President, Fort Pitt Steel Casting Co., Twenty-fifth St. and B. & O. R. R., McKeesport, Pa.

HALL, T. H., Metallurgist, Aeronautical Inspection Directorate, Air Ministry, Cardington, Bedfordshire, England. For mail: 52 Midland Road, Bedfordshire, England.

HAVENS, W. W., Supervising Engineer, Works Progress Administration, Box 5, Tremont Station, New York City.

HAWAII, COUNTY OF MAUI, Joseph Matson, Jr., County Engineer, Wailuku, Maui, Hawaii.

HOWES, B. A., Chief of Specification and Materials Section, Technical Division, U. S. Housing Authority, Washington, D. C.

HRUSKA, J. H., Metallurgical Engineer, Electro-Motive Corp., Fifty-fifth St. and Joliet Road, La Grange, Ill.

JORDAN, G. W., Chief Chemist, Southern States Portland Cement Co., Box 155, Rockmart, Ga.

LOUISIANA POLYTECHNIC INSTITUTE LIBRARY, Ruston, La.

MAINE STATE HIGHWAY COMMISSION, L. D. Barrows, Chief Engineer, Augusta, Me.

MEXICO SECRETARIA DE LA ECONOMIA NACIONAL, Departmento Administrativo, Avenida Republic Argentina 12, Mexico, D. F., Mexico.

MORRIS, M. J. R., Chief Metallurgist, Central Alloy Division, Republic Steel Corp., Massillon, Ohio.

OKERBERG, P. E., Sales Dept., Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.

REMMEY, G. B., Ceramist, R. C. Remmey Son Co., Hedley St. and Delaware River, Philadelphia, Pa.

RICHMOND, H. H., Chief Engineer, Electric Steel Foundry, 2141 N. W. Twenty-fifth Ave., Portland, Ore.

ROBERTSON, J. A., Chief Design Engineer, Warren Telechron Co., Ashland, Mass.

ROONEY, J. H., State Liaison Officer, Works Progress Administration of Tennessee, Nashville, Tenn. For mail: 207 Fairfax Ave., Nashville, Tenn.

SANDLER, ROBERT, Chief Chemist, Anglo-Alpha Cement, Ltd., Box 15, Roodepoort, Transvaal, South Africa.

SHERRICK, PAUL, Technical Adviser, E. H. Sargent and Co., 155 E. Superior St., Chicago, Ill.

VACCHELLI, P., R. Politecnico di Milano, Laboratorio Prove Materiali, Piazza Leonardo da Vinci 32, Milan, Italy.

NECROLOGY

We announce with regret the death of the following members:

C. F. HIRSHFELD, Chief of Research Dept., The Detroit Edison Co., Detroit, Mich. Doctor Hirshfeld died on April 19, in Detroit, after a long illness. Since 1916, he had been the representative of his company's membership in the Society. Just recently, The Detroit Edison Co. became a Sustaining Member of the Society. He had represented his company on Committee A-5 on Corrosion of Iron and Steel, and was a representative of The American Society of Mechanical Engineers on the Joint Committee on Boiler Feedwater Studies, but his activity in Society affairs was far wider than the work of these committees. His sustained interest in many projects and support of standardization and research work in the field of materials has been a stimulus for the activities of many of his associates in The Detroit Edison Co. on numerous A.S.T.M. committees and in other ways. His pioneering work in establishing research on an organized basis among public utilities did much to stimulate this activity throughout the country.

Doctor Hirshfeld had been concerned with engineering, research and education for 36 years. He was a member of many technical and scientific bodies and various clubs. His writings included several books and many technical and related papers.

FREDERICK KENNEY, Consulting Chemist, Hewlett, N. Y. Personal member since 1936; previously for many years representative of the membership of the New York City Central Testing Laboratory, Department of Purchase. Mr. Kenney was a member of Committee D-1 on Paint, Varnish, Lacquer, and Related Products and Subcommittees III, VIII, IX, XII, and XVIII; of Committee D-2 on Petroleum Products and Lubricants; of Committee D-12 on Soaps and Other Detergents and Subcommittees I, II and Chairman of Subcommittee III on Nomenclature and Definitions. He was the representative of Committee D-12 on Committee E-8 on Nomenclature.

C. B. MURRAY, President, Crowell & Murray, Inc., Cleveland, Ohio. Member since 1904. Mr. Murray was a member of the Cleveland District Committee. Mr. Murray's death was a very tragic one. He and Mrs. Murray had alighted from a trolley car and in a dense fog were struck by a car. Mr. Murray was killed almost instantly, Mrs. Murray living for a few days. He had been a loyal A.S.T.M. member and was on the Cleveland District Committee from 1931 serving as Vice-Chairman from 1935 until his death. The other officers of the Cleveland District Committee and several A.S.T.M. members attended the double funeral.

H. G. TAYLOR, President, Ball Chemical Co., Pittsburgh, Pa. Member since 1916.

ALFRED F. THEARD, General Superintendent, New Orleans Sewerage and Water Board, New Orleans, La.

Index to Advertisers

Provisional Program

FORTY-SECOND ANNUAL MEETING

of the

AMERICAN SOCIETY FOR TESTING MATERIALS

ATLANTIC CITY, N. J. **CHALFONTE-HADDON HALL** **JUNE 26 to 30, 1939**

Summary

	Morning	Afternoon	Evening
Monday, June 26	Registration Committee Meetings	Exhibit opens—noon Committee Meetings	Committee Meetings
Tuesday, June 27	1. 10:30 a.m. Formal Opening Session	2. Paint and Related Products 3. Iron	4. Water Round-Table Discussion of Effect of Sub-Atmospheric Temperatures on the Properties of Metals.
Wednesday, June 28	5. Paper, Plastics, Rubber, Glass, Electrical Insulating Materials 6. Fatigue, Corrosion	7. Soaps, Textiles, Timber 8. Coal, Petroleum Products, Gaseous Fuels 9. Edgar Marburg Lecture, 4 p.m.	10. Radiography, Magnetic Testing, Metallography 11. Soils
Thursday, June 29	12. Steel, Ferro-Alloys, Effect of Temperature 13. Bituminous Materials, Road Materials Round-Table Discussion on Quantitative Spectrography	Round-Table Discussion on Freezing-and-Thawing Tests Round-Table Discussion on Quantitative Spectrography (continued) Golf Tournament	14. Ceramic and Masonry Materials 15. Methods of Testing Round-Table Discussion on Quantitative Spectrography (continued)
Friday, June 30	16. Cement, Concrete, Lime, Gypsum	17. Concrete (continued) 18. Non-Ferrous Metals	

Hours are given in Eastern Daylight Saving Time.

Tuesday, June 27 10.30 A.M. First Session
Formal Opening Session
President's Address

Formal Opening of the Forty-second Annual Meeting. President T. G. Delbridge.

Report of Committee E-9 on Research. T. S. Fuller, Chairman.

Contains a brief discussion on the new research activities being undertaken or sponsored by Society committees, and references to the work of the several research committees.

Report of Committee E-10 on Standards. Cloyd M. Chapman, Chairman.

Reports on specifications and methods of test submitted under the procedure for acceptance and publication of new and revised tentative standards and tentative revisions of existing standards in the interim between annual meetings of the Society. Reports on action taken to organize new committee on sulfur cements. Reviews standardization projects considered during the year.

Annual Report of the Executive Committee. C. L. Warwick, Secretary-Treasurer.

A general report of Society activities with particular reference to membership, publications, finances, and administrative matters relating to committee activities and inter-society relations. Revisions in Society By-laws and the Regulations Governing Standing Committees are submitted as the result of a review of the standardization procedure and in order to provide for changes in method of publication of standards.

Annual Address by the President, T. G. Delbridge. "Glimpses at Petroleum."

Recognition of Forty-year Members.

Introduction of Newly Elected Officers.

The terms of the new officers, under the provisions of the By-laws, begin at the close of the annual meeting.

Miscellaneous Business.

Tuesday, June 27 2 P.M. Second Session
Held Simultaneously with Third Session
Paint and Related Products

Report of Committee D-1 on Paint, Varnish, Lacquer, and Related Products. H. E. Smith, Chairman.

This report includes new specifications and methods of chemical analysis of zinc dust (metallic zinc powder), a new test for orpiment in orange shellac, and a method for determining the elongation of attached lacquer coatings using conical mandrel test apparatus; also a procedure for toluene (toluol) dilution ratio of lacquer solvents.

As a result of a critical review given by the committee during the year to the standards under its jurisdiction, a number of revisions are presented in the existing specifications and methods of test for pigments and other paint materials.

Symposium on Paint Testing

It is proposed to give a program of informal papers on a variety of tests that have been found useful in the evaluation of the physical and chemical properties of paint and varnishes. Demonstrations will accompany many of the tests. The subjects will comprise color, gloss, fading of house paints, adhesion of house paints, flexibility of films, texture of pigmented films, stability of dipping coatings, application of metal coatings, and the like.

Tuesday, June 27 2 P.M. Third Session

Held Simultaneously with Second Session

Iron

Report of Committee A-2 on Wrought Iron. C. B. Bryant, Chairman.

This report contains a brief account of committee activities and recommends the adoption as standard of five tentative specifications for wrought-iron tubes, plates, rivets, rolled shapes and bars, and refined bars. Revisions published during the past year as tentative are recommended for inclusion in seven standard specifications for sheets, pipe, forgings, staybolt iron, and chain.

Report of Committee A-3 on Cast Iron. W. H. Rother, Chairman.

This progress report discusses considerations being given by the committee to changes in the specifications for car wheels and a revision of the standard specifications for cast-iron soil pipe and fittings. The pending tentative revision of the standard specifications for gray-iron castings for valves, flanges and pipe fittings, providing requirements for an additional class C iron is recommended for adoption. The standard specifications for the arbitration test bar and tension test specimen are recommended to be withdrawn.

Mechanical Properties of High-Strength Cast Iron. Jasper O. Draffin and W. Leighton Collins, University of Illinois.

Presents the results of a complete series of tests on a high-strength cast iron, all the material coming from a single heat. These tests continue, and to some extent parallel, similar tests made on ordinary gray iron which were reported in papers presented before the Society in 1937 and 1938.

Tension tests are made on solid and hollow specimens; compression tests on two lengths of specimens; torsion tests on solid specimens ¾ and 1 in. in diameter and on hollow specimens of different wall thicknesses; tests in repeated torsion with both solid and notched specimens; and in bending on solid rectangular and I sections. Poisson's ratio is determined in the beam tests.

Influence of Chromium on the Oxidation Resistance of Cast Iron. Charles O. Burgess, Union Carbide and Carbon Research Laboratories, Inc.

The oxidation resistance of a series of cast irons containing from 0 to 25 per cent of chromium is measured at temperature levels of 700, 800, 900, and 1000 C. Exposure periods up to 360 hr. are employed and the technique used to insure comparable conditions is described. The surface and interior structural changes brought about by such exposures are traced and the percentage of chromium necessary to produce an adherent scale determined. The data so obtained definitely indicate the percentage of chromium necessary to reduce the total or progressive oxidation of cast iron to a given level at each of the test temperatures.

Report of Committee A-7 on Malleable-Iron Castings. E. K. Smith, Chairman.

New specifications for pearlitic malleable castings are presented for publication as tentative. The report also recommends for adoption as standard the tentative specifications for cupola malleable iron.

The Resistance of High-Silicon Malleable Iron to Drilling. H. A. Schwartz, National Malleable and Steel Castings Co., R. C. Kasper and N. E. Mertz, Case School of Applied Science.

The machinability by drilling of malleable cast iron ranging from 2.09 to 2.36 per cent carbon, and from 1.39 to 2.10 per cent silicon has been determined in the Olsen Efficiency Machine. Both elements are shown to reduce the resistance to drilling.

It is not desired that these data should be interpreted as to the desirability or practicability of making metal of this composition for any particular commercial purpose. The data apply in the absence of primary graphite. This is not to say that that absence can always be relied on.

The Relation of Carbon Nodule Size and Tensile Properties of Malleable Cast Iron. H. A. Schwartz, National Malleable and Steel Castings Co., H. J. Schindler and J. F. Elliott, Case School of Applied Science.

A given white cast iron was converted into malleable irons varying widely in nodule number. It is shown that a great variation in nodule number is of little effect on the tensile strength and yield strength but that small nodule number is favorable to ductility.

Report of Sectional Committee A 21 on Specifications for Cast-Iron Pipe and Special Castings. T. H. Wiggin, Chairman.

Reports completion of specifications for cast iron pit cast pipe for water or other liquids, method of pipe thickness calculations, specifications for cast iron pit cast pipe for gas, and specifications for mortar lining.

Tuesday, June 27 8 P.M. Fourth Session

Held Simultaneously with Round-Table Discussion on Sub-Atmospheric Temperatures

Water

Report of Committee D-19 on Water for Industrial Uses. Max Hecht, Chairman.

This progress report on the activities of the committee during the year discusses briefly the work of its subcommittees in reviewing the existing methods of sampling and testing industrial waters. Reference is made to the preparation of a draft covering procedures for reporting water analyses and on the accumulation of data and study of methods for the determination of dissolved oxygen to serve as the basis for a new tentative standard.

Report of Joint Research Committee on Boiler Feedwater Studies. C. H. Fellows, Chairman.

The pH, Dissolved Iron Concentration, and Solid Product Resulting from the Reaction Between Iron and Pure Water at Room Temperature. Richard C. Corey and Thomas J. Finnegan, Consolidated Edison Company of New York, Inc.

Discusses the fundamental corrosion reaction between iron and water at room temperature. The work was conducted in iron vessels, and the water which was used was free of dissolved oxygen and carbon dioxide.

It is shown that the solution reached a pH value of approximately 8.3 and contained about 0.2 p.p.m. of dissolved iron. The solid product of the reaction is predominantly Fe_3O_4. Previous investigators have reported pH values of the order of 9.0 to 9.6 but it is believed that the use of glass vessels was responsible for the higher results.

The Calculation of Equilibria in Dilute Water Solutions. D. S. McKinney, Carnegie Institute of Technology.

This paper covers the general method for solving equilibrium problems from fundamental principles, the use of ion activities and the Debye-Hückel equation, and the calculation of equilibria at elevated temperatures from data obtained at room temperature. Application of these principles and methods to examples in the field of industrial water treatment is given.

The Calculation of the Distribution of Carbon Dioxide Between Water and Steam. A. M. Amorosi and J. R. McDermet, Elliott Co.

Curves, tabulations, and methods of calculation are provided showing the distribution of carbon dioxide dissolved in water in its three forms, H_2CO_3 (free CO_2), HCO_3^- (bicarbonate ion), and $CO_3^=$ at pH values varying from 3 to 12 for the temperatures 77, 150, 215, 235, 255, 275, 295 and 315F. The distribution between the three phases is found to be a function of temperature.

Calculations are shown indicating how to use these curves to determine the distribution of CO_2 in industrial waters, based upon a chemical titration method for determining the distribution between the three phases of solution at normal laboratory temperature.

An actual application of these CO_2 curves to apparatus commonly employed for mechanically removing CO_2 in connection with water-softening equipment is presented.

Determination of the Purity of Steam from Boilers by the Evaporation Method. R. C. Ulmer, The Detroit Edison Co.

The limitations of the conductance method for determining steam purity are discussed and illustrated. The inability to interpret the results, especially when ammonia was present in the steam, shows that there is need of a more accurate method for determining steam purity. The use of the evaporation method for determining steam purity gives accurate results as shown by the data given, but considerable time is required to obtain the results. An apparatus is described which makes it possible to obtain such results in from five to seven days and which requires very little supervision.

Electrical Conductance Measurements of Water Extracts of Textiles. A. C. Walker, Bell Telephone Laboratories, Inc.

It has been shown that the electrical properties of textiles depend upon chemical composition, water-soluble electrolytic impurities, moisture content, and manner of drying the material from the wet state. Selection of a textile for electrical purposes should include consideration of the influence of chemical composition upon the properties of the material, absence of significant amounts of electrolytes, and the method of drying the material from the wet state.

This paper discusses the water extract conductivity method, its correlation with insulation resistance data, and describes a simple, durable electrolytic cell which is convenient to use for the conductivity measurements.

Tuesday, June 27 8 P.M.

Held Simultaneously with Fourth Session

Round-Table Discussion of Effect of Sub-Atmospheric Temperatures on the Properties of Metals

In a wide and ever-widening field of engineering there is a demand for metals having properties which make them suitable for use at sub-atmospheric temperatures. Within this field, to mention a few, are oil refineries, aircraft, railroads and various chemical processes involving refrigeration. It is fairly well established that, while the strength of metals usually increases at sub-atmospheric temperatures, toughness frequently falls off to the point where some metals become dangerously embrittled. Particularly in the case of some steels, the structure imposed by heat treatment is frequently a vital factor in determining the suitability of the metal to withstand stresses at low temperatures. For a given composition of metal there is frequently a limit to the temperature to which it may safely be reduced in service and below which the metal is wholly unsuitable. While there is a considerable amount of information extant bearing on the behavior of metals at low temperatures, there is a need and a demand for gathering together all the available knowledge possible on the subject in a form in which it will be available to engineers and metallurgists.

It is the purpose of the Joint Committee on the Effect of Temperature on the Properties of Metals through this Round-Table Discussion, in which those having experience in the application of metals to low temperature service will take part, to develop to some degree the extent of our present knowledge of the behavior of metals in such service and to indicate the gaps which exist in such knowledge so that steps may be taken to make our knowledge more complete.

Sub-Size Charpy Relationships at Sub-Zero Temperatures. H. Habart and W. J. Herge, National Tube Co.

Charpy impact tests were made on eight steels at 70 F. and sub-zero temperatures down to —150 F. Standard and various sub-size specimens were broken at each testing temperature. In general, ferritic steels lost impact resistance, as measured on standard and two-thirds size specimens, when the testing temperature was decreased. One-half size specimens also lost impact resistance, but not to the marked degree as larger size specimens. Smaller specimens have practically constant impact resistance throughout the temperature range used. The results of the tests were summarized to show relationships between sub-size impact specimens and standard size specimens at each testing temperature.

Factors Affecting Notched-Bar Impact Tests of Steel at Low Temperatures. Walter Crafts and John J. Egan, Union Carbide and Carbon Research Laboratories, Inc.

In order to determine the reasons for lack of correlation between different makes of Charpy and Izod type impact testing machines in tests at low temperatures, a survey has been made to evaluate some of the variables that might produce the differences. Tests at low temperatures of both Izod and Charpy types were made on a machine in which the initial energy and velocity of blow could be varied independently. The notch radius and depth were also investigated to estimate sensitivity to accuracy of the specimen dimensions. The length of cantilever arm of an Izod machine was also studied. The results indicated a general, but not extremely accurate, correlation between different makes of machines and a conservative use of the test for specification purposes is recommended.

Wednesday, June 28 9.30 A.M. Fifth Session

Held Simultaneously with Sixth Session

Paper, Plastics, Rubber, Glass, Electrical Insulating Materials

Report of Committee D-6 on Paper and Paper Products. R. C. Griffin, Chairman.

This, the first report of the committee, discusses the activities of the committee since its organization in 1937, including considerations being given by the subcommittees to paper testing methods, the preparation of a monograph on the significance of test methods, and an extensive research testing program by six cooperating laboratories of fibreboard and fibreboard containers to secure data on the moisture contents and effects of conditioning such containers.

The first two methods completed by this committee covering tests for machine direction of paper and a procedure for determining the amount of paraffin in treated and waxed papers are presented for publication as tentative.

Report of Committee D-20 on Plastics. W. E. Emley, Chairman.

This report presents for publication as tentative the first two methods developed by this committee since its organization in 1937. The procedures include tests for index of refraction of transparent organic plastics and a test for resistance of plastics to chemical reagents. The report discusses briefly the considerations being given to other methods of testing plastics which include procedures for strength, hardness, flow under molding conditions, changes on heating, flammability, other optical tests, and tests for permanence, including procedures for resistance to light, heat, and moisture.

A New Oscillograph for Routine Tests of Rubber and Rubber-Like Materials. F. L. Yerzley, E. I. du Pont de Nemours and Co., Inc.

Describes a mechanical oscillograph which has been developed for routine laboratory tests of rubber and rubber-like compositions intended for cushioning services. It may be used to measure

1. Static characteristics: (*a*) loading and unloading, (*b*) creep under a given dead load, and (*c*) set.
2. Dynamic characteristics: (*a*) energy absorption during impact loading, (*b*) resilience, and (*c*) effective dynamic modulus.

Data are obtained in fundamental units which should be useful both to rubber technologists and to mechanical engineers.

Report of Committee D-11 on Rubber Products. O. M. Hayden, Chairman.

This report contains a number of recommendations on work accomplished during the year and includes a summary of new projects under way or contemplated by the committee. New specifications for rubber sheath compound for electric cords and cables, and a new test for the effect of compression-hysteresis on vulcanized rubber is submitted as tentative. A plasticity test using the Pusey and Jones apparatus is also included and testing procedures for hard rubber, including methods for physical tests, chemical analyses, and electrical properties of this material, are presented.

Three tentative methods are recommended for adoption as standard and revisions are presented in three tentative specifications and five methods; also pending tentative revisions in two standards are recommended for adoption.

Announces the organization of a new technical committee on automotive rubber in cooperation with the S.A.E. to undertake development of standards for rubber used in automotive applications. The report summarizes various activities under way in the committee, the more important of which include the completion of a classification of packings and gaskets and survey of existing tests and specifications; discussion of adhesion test for tape; analytical tests for copper and manganese in rubber; study of method for air pressure heat test. Presents a résumé of cooperative tests for determining viscosity of cements, and summary of studies of tests for sponge rubber.

Properties of Rubber Revealed by Mechanical Tests. F. L. Yerzley, E. I. du Pont de Nemours and Co., Inc.

Elasticity, energy, resilience, and hysteresis loss are defined in an effort to clarify terminology essential to a discussion of mechanical tests. Several familiar test methods are examined with respect to the measurement of elastic properties. These tests include tension tests, compression set, rebound tests, the compression oscillograph, the Goodrich flexometer, and hardness tests. The paper shows the correlation between the tests and the needs they are intended to fill, and points out shortcomings and ways of overcoming them.

Report of Committee C-14 on Glass and Glass Products. G. W. Morey, Chairman.

This report presents for publication as tentative the first six methods completed by this committee since its organization in 1937. The methods cover procedures for chemical analysis of glass sands, modulus of rupture of glass specimens, thermal endurance of glass rods, test for resistance of glass bottles to internal pressure, polariscope examination of glassware, and method for determining resistance of glass containers to thermal shock.

A report is also included on the cooperative program carried out during the year on studies of chemical durability of glass.

Physical Properties of Laminated Glass. W. R. Koch and E. J. Wyrostek, Wright Field.

Comparative data on laminated glasses composed of various plastics and types of glass are discussed with reference to aircraft use. The development of pressure cabin structures has required strength data on glass which have been obtained in this study at normal and at low temperatures. Methods and results of tests on index of refraction, spectral transmission, optical distortion, scatterability, impact, and bursting strength of laminated plate and of laminated heat-treated plate glass of various rectangular dimensions and thicknesses are included.

Report of Committee D-9 on Electrical Insulating Materials. T. Smith Taylor, Chairman.

Revisions are presented in the tentative methods of testing varnishes used for electrical insulation, test for dielectric strength of insulating materials at commercial power frequencies, specifications for black bias-cut varnished cloth tape, and method of testing pin-type, lime glass insulators. Three standards are recommended for adoption as standard with minor revisions providing for the conditioning of the material before testing in order to secure better reproducibility of results. These methods cover tests for sheet and plate materials, laminated tubes, and round rods used in electrical insulation. The tentative revision presented in the 1938 report is recommended for incorporation in the standard methods of testing molded materials used for electrical insulation.

Wednesday, June 28 9.30 A.M. Sixth Session

Held Simultaneously with Fifth Session

Fatigue, Corrosion

Report of Research Committee on Fatigue of Metals. H. F. Moore, Chairman.

This report discusses the progress made during the past year in initiating the research project to investigate the effect of type of testing machine on fatigue results, which includes tests of various metals by cooperating laboratories using rotating-beam, rotating-cantilever, Haigh tension-compression, and de Forest Rayflex vibratory machines.

Fatigue Tests of Wire. C. P. Wampler, A. O. Smith Corp. (Formerly University of Illinois), and N. J. Alleman, University of Illinois.

Describes a relatively inexpensive type of fatigue testing machine capable of testing wire or rod from 1/32 to 3/16 in. in diameter and includes the results of some tests performed on materials of different size and composition. The machine embodies the same principles of load application and stress calculation as used in the Haigh-Robertson wire testing machine which was developed in England.

Since the specimens require no machining, the fatigue strength obtained is of the material as it is commercially used. One of the materials used in the investigation is the Mt. Hope bridge wire. The results described are in close agreement with published results on similar materials from other types of machines.

Fatigue Strength of Machined Forgings 6 to 7 in. in Diameter. O. J. Horger and H. R. Neifert, The Timken Roller Bearing Co.

The Association of American Railroads is making extensive laboratory tests to determine the fatigue strength of full-size railroad car axles, and this paper forms a progress report on some of this work. Discusses rotating cantilever beam fatigue tests made on about 24 steel forgings from the same heat of S.A.E. No. 1045 steel machined to a tapered test section having a diameter of 6 to 7 in. These specimens were tested in the as-forged condition without heat treatment but machined after forging to a smooth turned surface.

Data are included on scale-size fatigue tests of 1½ and 0.3 in. diameter specimens. Metallurgical studies and profilograph records of surface finish supplement the fatigue tests. A discussion of test results with reference to those of previous investigators is also given.

Fatigue Machines for Testing Structural Units. R. L. Templin, Aluminum Company of America.

Describes in some detail three types of large fatigue testing machines which have been designed and built for making fatigue tests of structural units such as joints, beams, columns and frames under normal working loads. The calibration and operation of the machines are discussed and from the results obtained during the past four years it is concluded that satisfactory machines for testing structural units have been developed. A limited amount of test data is included.

Report of Committee A-5 on Corrosion of Iron and Steel. W. H. Finkeldey, Chairman.

This report includes extensive data from the comprehensive atmospheric corrosion test program being conducted at 11 test sites throughout the country on specimens of farm field fencing, and fence wire. The conditions of the specimens at the various test sites after 2¼ yr. exposure are recorded in the inspection data. Conclusions as seem warranted by the data at hand are reported.

Additional failures of the sheets in the outdoor corrosion test at Annapolis are reported, this program including black iron and steel sheets exposed continuously for over 21 yr. A report is included on the galvanized sheets exposed at 4 test locations.

As a result of a critical review by the committee of the standards under its jurisdiction, revisions are recommended in several specifications covering zinc-coated wire and wire products. Revisions are also submitted in the three specifications for electrodeposited coatings on steel together with a method for taking samples and procedures for determining the thickness of such coatings. The report indicates that further consideration is being given by the committee to the Preece test for uniformity of galvanized coatings.

Report of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys. T. S. Fuller, Chairman.

Of special importance in this report are the results of the corrosion tests of galvanic couples after exposure of 7 yr. at 9 test locations representing various atmospheric conditions. Extensive data are presented on some 20 different metal combinations. Conclusions as seem warranted by the data are presented. Results of some preliminary tests of galvanic couples exposed in sea water and of stainless steel coupled with non-ferrous metals and exposed to salt spray are also included.

A new method covering suitable apparatus and procedures for making salt spray tests of solid, duplex, plated, and coated non-ferrous metals is presented for publication as tentative. The report announces the formulation of plans to study total immersion tests using three solutions (sodium chloride, sulfuric acid, and sodium hydroxide) and testing six metals in each solution in order to determine the reproducibility of results.

Paper Appended:

Chemical Removal of Corrosion Products in the Determination of the Corrosion Rate of Zinc. E. A. Anderson and C. E. Reinhard, The New Jersey Zinc Co.

The commonly used method of determining the corrosion rate of zinc from the straight-line portion of a simple weight change curve based on periodic weighings with the corrosion products in place is shown to cause serious errors. Data are cited to illustrate the greater reliability of corrosion rate figures based on weight changes determined after chemical removal of the corrosion products. The same data show the difference in corrosion rate of two rolled zinc materials during three separate 8-hr. periods of the day.

Atmospheric Corrosion of Non-Ferrous Metals and Alloys. C. W. Borgmann, University of Colorado.

The test results, published to date by Committee B-3 on the atmospheric corrosion of non-ferrous metals in nine different locations are critically reviewed. The measurements of change in elongation and tensile strength are used as criteria to judge the severity of corrosion by various atmospheres and also to classify the materials with respect to their corrosion resistance. The limitations to be borne in mind in any rating of the materials are discussed at length. The value to the engineering profession of the work being carried on is stressed.

Report of Joint Committee on Exposure Tests of Plating on the Non-Ferrous Metals. William Blum, Chairman.

A progress report presenting a summary of the inspections and conclusions to date of the corrosion tests of plating on non-ferrous metals exposed at 6 test locations since 1936.

Wednesday, June 28 1.30 P.M. Seventh Session

Held Simultaneously with Eighth Session

Soaps, Textiles, Timber

Report of Committee D-12 on Soap and Other Detergents. H. P. Trevithick, Chairman.

Six new specifications for detergents covering sodium silicate, trisodium phosphate, palm oil soap, built soap, and soap powder are presented. Three new procedures for the methods of analysis of special detergents include a test for carbon dioxide in caustic soda by the evolution method and tests for sodium metasilicate and trisodium phosphate.

The report recommends the adoption as standard of six existing tentative specifications for soap and three methods of testing.

The brief summary of work under way in the committee discusses the considerations being given to specifications and methods of test for liquid and paste soaps, scouring powder, and other phosphates and silicates. The difficult problem of evaluating detergency is also being studied and work is under way on specifications and methods for dry cleaning and metal detergents.

Report of Committee D-13 on Textile Materials. H. J. Ball, Chairman.

This report summarizes briefly the extensive activities of the committee during the year. It announces the formation of a supcommittee on glass textiles and the initiation of a research program on the evaluation of textile finishes.

The report includes comprehensive methods of test for rayon staple, new methods of test for single jute yarn, and a procedure for measuring the apparent fluidity of dispersions of cellulose fibers in cuprammonium hydroxides, all of which are recommended for publication as tentative. A critical review by the committee of the standards under its jurisdiction has resulted in the presentation of recommendations for the adoption as standard of six tentative standards, revisions in three tentative standards, the adoption of tentative revisions in four standards, and the submission of new revisions in four standards.

Report of Committee D-7 on Timber. Hermann von Schrenk, Chairman.

This report recommends the adoption as standard of the tentative specifications for zinc chloride and a revision of the tentative method of test for tar acids in creosote and creosote-coal tar solutions. An informational report on interpretation of knot dimensions to serve as a guide in connection with the specifications and definitions of "knots" in various grades and species of timber is included in an appendix.

Report of Committee C-5 on Fire Tests of Materials and Construction. R. P. Miller, Chairman.

A progress report recommending the continuation without revision of the standard specifications for fire tests of building construction and materials and the tentative specifications for fire-retardant properties of wood for scaffolding and shoring.

Report of Committee D-17 on Naval Stores. F. P. Veitch, Chairman.

This progress report discusses the cooperative studies being made by members of the committee on the use of a shouldered ring in determining softening point of certain resins and rosins; also further tests on crystallizing tendency of rosin, and studies of the present tentative methods for acid number and saponification value of rosin. Study of a method for unsaponifiable matter is also under way.

Report of Committee D-10 on Shipping Containers. Edward Dahill, Chairman.

This progress report discusses a new test device for containers of interest in connection with the work of the committee.

Wednesday, June 28 1.30 P.M. Eighth Session

Held Simultaneously with Seventh Session

Coal, Petroleum Products, Gaseous Fuels

Report of Committee D-5 on Coal and Coke. A. C. Fieldner, Chairman.

This progress report discusses considerations being given by the committee to the test for fusibility of coal ash, methods of testing grindability of coal, the drop shatter and tumbler tests for coal, further methods for sampling coal, and experimental work on the evaluation of available methods for testing expansion characteristics of coals in coke ovens and their general plastic properties during carbonization. Completion is reported of a method of test for dustiness of coal and coke; also the formulation of a proposed definition of the term "ignitibility" of a fuel.

Report of Sectional Committee M 20 on Classification of Coals. A. C. Fieldner, Chairman.

This report recommends the adoption as standard of the tentative definitions for varieties of bituminous and subbituminous coals and includes a brief review of the activities of the committee which have now reached completion.

Report of Committee D-2 on Petroleum Products and Lubricants. T. A. Boyd, Chairman.

New methods of test for ramsbottom carbon residue of petroleum products, a doctor test for motor fuels, naphthas and kerosines, and tests for gum stability and tetraethyl lead in gasoline are presented for publication as tentative. The test for acid heat of gasoline and knock characteristics of motor fuels, with revisions, are recommended for adoption as standard. Revisions are also presented in the tentative method of test for saponification number, vapor pressure, and kinematic viscosity, and the adoption of tentative revisions in three standards are recommended.

The report also includes the tests for thermal value of fuel oil and for sulfur in petroleum oils by bomb method which have been rewritten and extensively changed in form and arrangement. A consolidation of the two present standard methods of test for color by A.S.T.M. Union colorimeter is presented. The withdrawal of the test for expressible oil and moisture in paraffin waxes is recommended.

Appended to the report are a summary of the studies carried on in the development of the new method for gum stability of gasoline and a report of the work undertaken in preparing the test for tetraethyl lead in gasoline. A draft of proposed specifications for aviation gasoline is included as information.

Report of Committee D-3 on Gaseous Fuels. A. C. Fieldner, Chairman

This progress report discusses considerations given by the committee to the standardization of test methods for gaseous fuels. It includes a résumé of activities of the seven subcommittees on collection and on measurement of gaseous samples, on calorific value of gaseous fuels, on specific gravity and density, on determination of impurities of gaseous fuels, on water vapor content, and on analysis of gaseous fuels.

The Determination of Organic Sulfur in Gas Mixtures by the Catalytic Hydrolysis Method. Lawrence T. Jilk, E. I. du Pont de Nemours and Co.

A new analytical method for determining organic sulfur in gas mixtures without the use of a flame or any exposed hot body is described. The gas to be analyzed is first freed from oxygen by means of an acidic chromous chloride solution and from hydrogen sulfide by means of a slightly alkaline cadmium chloride solution. The gas is then passed through a bed of activated alumina held at 500 C, wherein the organic sulfur compounds are converted to hydrogen sulfide. The hydrogen sulfide is absorbed in an alkaline cadmium chloride solution and titrated iodimetrically.

Recent Experiments on Laboratory Wet Gas Meters. Howard S. Bean and F. C. Morey, National Bureau of Standards.

The relation of laboratory wet gas meters to the determination of the heating values of fuel gases is discussed. Any decrease in the uncertainties of these determinations will involve, among other things, a decrease in the possible errors of metering the gas. To aid in decreasing these errors experiments have been made on:

The possible errors due to the use of fractional revolutions;
Relation between the relative humidity of the entering gas and meter indications;
Effects of oil fogs on meter indications;
Relative temperatures of gas, meter, and room;
Testing meters under moving start and finish.

Report of Sectional Committee Z 11 on Petroleum Products and Lubricants. T. A. Boyd, Chairman.

Reports on standards being recommended for submission to American Standards Association for approval as American standard. Reports completion of the compilation of the summary of work in the field of petroleum products.

Wednesday June 28 4 P.M. Ninth Session

Edgar Marburg Lecture

The purpose of the Edgar Marburg Lecture is to have described at the annual meetings of the Society, by leaders in their respective fields, outstanding developments in the promotion of knowledge of engineering materials. Established as a means of emphasizing the importance of promoting knowledge of materials, the Lecture honors and perpetuates the memory of Edgar Marburg, first secretary of the Society.

Fourteenth Edgar Marburg Lecture: "Stress, Strain and Structural Damage," by Prof. H. F. Moore.

The metallurgist with his microscope and with his X-ray diffraction apparatus has shown that the internal structure of materials is far more complicated than our former simplified assumptions. In fact, the structure of materials seems so complicated that so far no mathematical analyst has had the hardihood to propose rigid formulas which fit all these new viewpoints. Our formulas are "statistical," and our tests at best are guides which have a high probability of usefulness in selecting materials. In this Marburg lecture there will be discussed various types of structural damage, and the value of our common test results as prophecies of resistance to structural damage.

Award of Charles B. Dudley Medal to Roy W. Carlson, Massachusetts Institute of Technology.

The Thirteenth Award of the Charles B. Dudley Medal will be made to Roy W. Carlson, Associate Professor of Civil Engineering, Massachusetts Institute of Technology, for his paper on "Drying Shrinkage of Concrete as Affected by Many Factors," presented before the Society at the 1938 annual meeting.

Wednesday, June 28 8.00 P.M. Tenth Session

Held Simultaneously with Eleventh Session

Radiography, Magnetic Testing, Metallography

Report of Committee E-4 on Metallography. L. L. Wyman, Chairman.

This report includes an extensive revision of the procedures for preparation of metallographic specimens. The remainder of the report is devoted to a brief summary of the activities of the committee on photography, X-ray, diffraction, dilatometry, and on the metallographic grain size standards.

Paper Appended:

Application of Color Photography to Metallographic Work. R. P. Loveland, Eastman Kodak Co.

The methods of color photography in metallographic work are briefly classified. The separation negative method can be made to give the most accurate reproduction, especially if the masking method is used when needed, since the same picture can be worked over, with sensitometric controls, until acceptable rendition is achieved. To utilize the advantages of the monopack methods, the quality of the illumination actually incident on the subject must be that specified in the manufacture of the film or plates. Methods of achieving this are discussed, with examples.

Report of Committee E-7 on Radiographic Testing. H. H. Lester, Chairman.

This report includes a detailed review of materials testing by X-ray methods. Reference is made to the cooperative work carried on during the year with other committees of the Society; also to the progress being made in the preparation of new standards for radiographing welds and castings and on a revision of the methods for radiographic testing of castings.

The Use of Radiography in the Development of Castings for Mass Production. Don M. McCutcheon, Ford Motor Co.

Presents an outline of the procedure followed in the development of automotive castings for mass production. Radiographic methods and technique are described showing how maximum detail is consistently secured. Microphotometer curves are presented of test sections with sensitivity gages showing why it is difficult to obtain a sensitivity greater than 2 per cent of section thickness. An X-ray sensitivity of 0.5 per cent is maintained on crankshafts whose bearing section is 2 in. thick. Minimum perceptible size of various defects is discussed based upon examination of large numbers of sections.

Factors Governing Practical Sensitivity of Radiographic Tests. H. H. Lester, Watertown Arsenal.

Shows that for relatively large cavities X-ray tests may be relied upon to reveal them when the depth of the cavity is 1 per cent or less in metal sections up to 3 in. For cracks, however, the sensitivity is more nearly 6 per cent for metal sections up to 2 in., when no bucky grid is used. The bucky grid is impractical for use with most castings and for the majority of structural welds exclusive of pressure vessel welds. Methods for better evaluation of sensitivity are discussed and data presented on effects of varying focal distances on image delineation and upon the effects of secondary radiation in reducing sensitivity.

Modern Testing of Aircraft Materials:

Correlation of Some Mechanical Tests of Aluminum Alloys with X-ray Tests. Tom A. Triplett, Triplett & Barton, Inc., and W. Lavern Howland, California Institute of Technology.

Some Mechanical Tests of Aluminum Alloys 14ST and 24ST. W. B. Mechling and S. S. Jack, California Institute of Technology.

Report of Committee A-6 on Magnetic Properties. Thomas Spooner, Chairman.

A new method of measuring lamination factor of structure composed of strips cut from electrical steel to supplement the existing general methods for magnetic properties of iron and steel is presented as tentative.

New definitions dealing with incremental magnetic properties are submitted as basic nomenclature for use in connection with an investigation of test methods being undertaken. The studies carried on by the committee during the year on alternating-current and direct-current test methods are briefly discussed.

Magnetic Analysis—Modern Methods and Applications. Theodor Zuschlag, Magnetic Analysis Corp.

This paper relates to the history and the present state of development of magnetic analysis. The first part describes early attempts to evolve practical instruments for magnetic inspection purposes. The second part is devoted to a general description of the methods and apparatus at present used by the Magnetic Analysis Corp. The third part deals with the factors which determine success or failure of magnetic investigations, particularly those related with the material predominantly subjected to production inspection.

Wednesday, June 28 8 P.M. Eleventh Session

Held Simultaneously with the Tenth Session

Soils

Report of Committee D-18 on Soils for Engineering Purposes. H. F. Clemmer, Chairman.

This report recommends adoption as standard of the seven existing tentative methods of testing soils. The report includes as information three new methods of test which are expected to be presented to the Society for publication as tentative subsequent to the annual meeting. These cover procedures for the moisture density relations of soil-cement mixtures, test for the durability of compacted soil-cement mixtures by repeated freezing and thawing, and a test for stabilization of soils with emulsified asphalt.

Symposium on Shear Testing of Soils.

The Symposium on Shear Testing of Soils is presented in order to bring before the engineering profession the most recent developments in this phase of soil mechanics, and to provide those interested in the problem with an opportunity to discuss and coordinate their ideas.

The problem of determining the shearing resistance of soils is a perplexing one. Probably no other physical characteristic has received more intensive study by those interested in understanding the fundamental mechanics of the action of soil under load. Those who have studied the subject most extensively recognize that different types of equipment and different procedures result in different values of shearing resistance in some types of soil. During the past few years interest in the subject has broadened, and many laboratories are working on the problem. Much excellent work has been done and it is important that the various points of view and lines of endeavor be brought together and discussed in order that further advances may proceed along sound lines.

Torsional Shear Tests and Their Place in the Determination of the Shearing Resistance of Soils. M. Juul Hvorslev, Harvard University.

Types of apparatus for torsional shear tests on soils are described, and sources of error in the test results, compared to translatory shear tests and tri-axial compression tests. While the torsional shear tests do not present special advantages for determination of the maximum shearing resistance, they probably offer the best and in the case of many clays, the only method, of determining the start and velocity of the slow plastic flow before failure, decrease of the shear resistance after failure and of the independence of this decrease on the velocity of the plastic flow after failure. The stress conditions, planes of failure and methods of determining the stress-strain curve for shear by graphical differentiation of the moment-twist diagram are described in an appendix.

Some Practical Aspects of Soil Shear Testing. Gregory P. Tschebotareff, Princeton University.

Different methods of preparation of soil samples and their effect on the subsequent shearing resistance of the test specimen are discussed.

The necessity is emphasized for discrimination between: first, shear tests made for the purpose of forecasting the actual numerical values of the shearing resistance of soils for stability analyses of engineering structures; and, second, shear tests made for the purpose of comparing the shearing resistance of different soils under identical conditions for purposes of selection of the more suitable material.

Essential Features of Triaxial Shear Tests. C. A. Hogentogler and E. S. Barber, U. S. Bureau of Public Roads.

The distortion of soil under stress affects the performance of road surfaces, subgrades, embankments, foundations, and retaining walls. The variety of methods now used to determine the resistance of soils to distortion are illustrated. The essential features of triaxial compression apparatus or stabilometers are shown and the test method, the results obtained, and their interpretation in terms of design are discussed. Various types and design features of stabilometers now in use are illustrated and compared.

Studies of Critical Void Ratio and Shearing Resistance of Cohesionless Soils by Means of a Triaxial Compression Machine. John D. Watson, Harvard University.

Cohesionless soils in a dense state will expand in volume when loaded to the point of failure, and rupture will occur along definite planes. The same soil in a loose state will continuously reduce in volume under load, and the failure will be a plastic flow rather than a rupture. Between the extremes of loose and dense states there is a so-called critical void ratio at which the volume change is zero. This critical void ratio is not a constant but varies with the magnitude of the stresses. The stress-strain relationship is also markedly different in the two states. These phenomena can be accurately observed only in a triaxial compression machine. A simple apparatus for this purpose is described, and the results of tests on several materials are given.

A Comparison of Results of Direct Shear and Cylindrical Compression Tests. Donald W. Taylor, Massachusetts Institute of Technology.

Shearing Resistance of Soil—Its Measurement and Practical Significance. W. S. Housel, University of Michigan.

Fundamental aspects of shearing resistance for both cohesive and granular soils are discussed with particular emphasis on some of the concepts which have led to divergent viewpoints on the subject. The relative importance of shearing resistance due to cohesion and internal friction is considered in both general types of soil.

The treatment of soil resistance is simplified by clearly differentiating between shearing resistance originating in molecular forces and those dependent on purely mechanical properties of a granular mixture. Criteria of failure for soils are reviewed to determine the requirements to be met in establishing conditions of static equilibrium in a soil mass. The mechanics of cohesion are conceived to involve the treatment of the soil-water system as a material which is an individual entity rather than a combination of two separate discontinuous phases.

Thursday, June 29 9.30 A.M. Twelfth Session

Held Simultaneously with Thirteenth Session and Round-Table Discussion on Quantitative Spectrography

Steel, Ferro-Alloys, Effect of Temperature

Report of Committee A-1 on Steel. N. L. Mochel, Chairman.

Of the many recommendations in this report the following are of particular interest and importance: Proposed new specifications for carbon-steel castings suitable for fusion welding for miscellaneous industrial uses; alloy-steel boiler and superheater tubes; electric-resistance welded heat exchanger and condenser tubes; carbon-steel castings and alloy-steel castings suitable for fusion welding for service at elevated temperatures. Possibly of outstanding importance among all of the recommendations because of their wide use in building codes and a great many branches of construction is the consolidation of the specifications for steel for bridges (A7) and steel for buildings (A9).

The adoption of revisions in numerous existing specifications include eight spring and spring bar standards; concrete reinforcing bar specifications; revisions of three carbon-steel forging specifications in the form of a new consolidated specification; incorporation of a new high tensile boiler rivet in the existing specifications for boiler rivet steel and rivets; and a number of modifications in various specifications covering materials for high-temperature service.

Finally, the adoption as standard of several existing tentative specifications among which are specifications for high-carbon and quenched carbon joint bars; normalized quenched-and-tempered alloy-steel forgings; one-wear and two-wear steel wheels; low-carbon-nickel plates for boilers; alloy-steel heat exchanger and condenser tubes and alloy-steel still tubes; and carbon and alloy-steel nuts for bolts for high-pressure and high-temperature service.

The Work-Brittleness Test. H. W. Graham, Jones & Laughlin Steel Corp., American Iron and Steel Works.

Discusses the observed defects of cold work on both brittleness and hardness of steels, and the variation in response of steels, otherwise considered identical, to such cold work. The problem of devising a simple test by which these phenomena may be measured is discussed, and some early attempts mentioned. Development of the "work-brittleness" test, which conveniently measures the "sensitivity" of a steel, or its response to cold work, is described in some detail, including various methods of applying cold work, and the effect of dimensions of the test on its selectivity.

Report of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. Jerome Strauss, Chairman.

This report contains information obtained from examinations of installations of plain chromium and chromium-nickel steel used for architectural purposes in New York City, Philadelphia, and Atlantic City to determine conditions of the material after exposure to industrial and sea-coast atmospheres. A study of intergranular precipitation in 18 per cent chromium, 8 per cent nickel corrosion-resisting steels is also reported.

A guide or recommended practice for corrosion testing in plant equipment is included and the report recommends for adoption as standard eight existing tentative specifications for alloy-steel corrosion-resistant castings and revisions in one specification for castings. Revisions for immediate adoption are recommended in two standards and the adoption as standard with revisions of one tentative specification for alloy-steel sheet, strip, and plate.

The Alloy Casting Research Institute Test Block for Heat-Resisting Alloys; Its History, Selection and Utilization. O. E. Harder, Battelle Memorial Institute

Certain survey work conducted by Battelle regarding the most suitable type of test specimen for use with heat-resisting alloys in determining high temperature tensile properties and creep characteristics is reviewed and some experiments on the use of a pot-type casting with a riser at the top and the specimens to be cut in a vertical direction are reported. While this type of casting produced a good yield of test specimens in proportion to the total metal cast, there was some trouble with unsound specimens. A wedge-shaped test block with a riser along the entire length but gated only at the bottom, which produces four tension test specimens, was next developed in cooperation with the A.C.R.I. Technical Committee. This block is described, together with its utilization in testing three types of heat-resisting alloys.

The Hastelloy Alloys, Their Physical and Corrosion-Resistant Properties. F. G. McCurdy, Haynes Stellite Co.

Report of Sectional Committee B 36 on Standardization of Dimensions and Materials of Wrought-Iron and Wrought-Steel Pipe and Tubing. H. H. Morgan, Chairman.

The action of the committee in recommending the American tentative standard for wrought iron and wrought steel pipe (B36.10-1935) for approval as American standard by the A.S.A. is reported together with detailed changes providing for the inclusion of references to additional A.S.T.M. specifications for pipe.

Report of Committee A-9 on Ferro-Alloys. Charles McKnight, Chairman.

This progress report discusses considerations being given by the committee to revisions in the eight specifications for ferro-alloys presented to the Society as tentative last year.

Report of Joint Research Committee of A.S.M.E. and A.S.T.M. on Effect of Temperature on the Properties of Metals. N. L. Mochel, Chairman.

Thursday, June 29 9.30 A.M. Thirteenth Session

Held Simultaneously with Twelfth Session and Round-Table Discussion on Quantitative Spectrography

Bituminous Materials, Road Materials

Report of Committee D-8 on Bituminous Waterproofing and Roofing Materials. J. M. Weiss, Chairman.

This report presents as tentative a new procedure for accelerated weathering tests on bituminous materials and a specification for asphalt mastic for use in waterproofing, the latter representing a consolidation of three existing specifications. The critical review by the committee of the standards under its jurisdiction has resulted in the presentation of revisions in four tentative specifications and one tentative method and the preparation of tentative revisions in two standards.

Report of Committee D-4 on Road and Paving Materials. E. F. Kelley, Chairman.

This report recommends revision in three tentative specifications, adoption as standard of eleven tentative standards and the reversion of three standards to the tentative status, which proposals have resulted from a critical review by the committee of the standards under its jurisdiction. Ten tentative specifications for asphalt cements of different penetration limits are recommended to be discontinued pending further study of these materials by the committee.

There are appended to the report as information two proposed specifications and two proposed methods. These cover a new test for sieve analysis of mineral fillers together with a report of cooperative tests using the method, specifications for an emulsion intended for use in densely graded cold asphaltic mixes, specifications for preformed expansion joint fillers for concrete, and methods of testing these expansion joint fillers.

Degradation of Aggregates Under Road Rollers. Tilton E. Shelburne, Joint Highway Research Project, Purdue University.

Field tests and observations, together with the determination of the amount and kind of degradation produced by road rollers in compacting typical surface aggregates, are described. Controlled variations in the type of base, weight and number of trips of the roller, and source, type, and grading of the aggregates are included. Field test results are correlated with the abrasion loss, or percentage of wear, as determined in the laboratory by means of the Los Angeles abrasion machine. Tables and graphs are shown illustrating the amount of degradation of the various aggregates produced under road rollers and also in the Los Angeles abrasion machine.

Evaluating the Adhesive Properties of Asphalts. August Holmes, Standard Oil Development Co.

One of the destructive forces frequently encountered in a road structure is that of moisture. This is particularly true for the hydrophilic aggregates. Various procedures are employed for measuring the adhesivity of asphalts to aggregates varying from the small partition test carried out in a test tube to the large circular track test. The usual paving asphalts do not appear to differ greatly in their adhesivity characteristics, but these can be materially improved by the addition of wetting agents. According to the described tests, improvement in adhesivity of 350 per cent over the untreated asphalt has been obtained in this manner. This work has been confined to straight asphalts and cutback asphalts only; the improvement in adhesivity of asphalt emulsions appears to be a separate problem.

Research in Soil Stabilization with Emulsified Asphalt. C. L. McKesson, American Bitumuls Co.

Soil stabilization with emulsified asphalt has been practiced quite extensively throughout the United States during the past five years. The test methods now generally used for designing emulsified asphalt stabilized mixtures and for determining the efficiency of stabilization are described. The research work involved in the development of these test methods is also described, and the significance of the methods is explained. A comparison is made between results of preconstruction design tests and results of similar tests made on field samples taken one to five years after construction.

Some Factors Affecting the Thermal Susceptibility of Asphaltic Paving Mixtures. Roland Vokac, Barber Asphalt Corp.

The influence of (*a*) mixture composition and (*b*) character of asphalt cement used on the thermal susceptibility of mixture strength is shown. It has been determined that although the thermal susceptibility of an asphaltic mixture is related to the susceptibility of the asphalt cement used as a binder, the mixture composition may have a strong tempering influence, particularly with respect to variations in filler content. Thermal susceptibility of a mixture may be reduced when highly susceptible asphalts are used by the use of a proper amount and kind of filler.

Thursday, June 29 9.30 A.M. Continuing in Afternoon and Evening

Held Simultaneously with Twelfth to Fifteenth Sessions and Round-Table Discussion on Freezing-and-Thawing Tests

Round-Table Discussion on Quantitative Spectrography

The round-table discussion is intended to cover the fundamental methods and technique of spectrography. The subject will be divided into a number of subgroups for each of which there will be a carefully selected discussion leader. One or two other individuals will be assigned to follow the leader, and for each particular subject a carefully selected recorded will be chosen. There will be no stenotypist. On the basis of the recorded notes and a correlated abstract of the discussion, the committee will organize for the following year a more formal symposium.

By making this early start in organizing a 1940 symposium, it is planned to have the symposium papers available sufficiently in advance of the meeting to permit the securing of ample written discussion.

Thursday, June 29 **2 P.M.**

Held Simultaneously with Round-Table Discussion on Quantitative Spectrography

Round-Table Discussion on Freezing-and-Thawing Tests

The primary purpose in arranging for this discussion on freezing-and-thawing tests is to determine whether any organized work should be undertaken by the Society in this field. Various committees in the past have given consideration to the possibility of developing a standard test procedure as applied to specific materials. In view of the common interest in these tests, and further, in view of a number of moot points that would require attention, such organized work might be warranted.

The extent of interest in the resistance of materials to freezing-and-thawing action is evidenced by the appearance on this Provisional Program of several papers dealing with some phases of durability and tests for its evaluation. The discussion on these papers may be made a part of the round-table discussion. It is proposed to designate various individuals as leaders of discussion to deal with some particular phase of the subject.

Thursday, June 29 **Afternoon**

Golf Tournament

Thursday, June 29 **8 P.M.** **Fourteenth Session**

Held Simultaneously with Fifteenth Session and Round-Table Discussion on Quantitative Spectrography

Ceramic and Masonry Materials

Report of Committee C-8 on Refractories. J. D. Sullivan, Chairman.

As a result of a critical review of the standards under its jurisdiction recommendations are presented for the adoption as standard of five tentative standards, revisions in two standards and two tentative methods, and the adoption of tentative revisions in three stndard specifications. A new load test for refractories at high temperature is submitted to replace the present standard method.

The report also includes two new industrial surveys of conditions surrounding refractory service in lime burning, and for continuous plate and window glass furnaces.

Report of Committee C-4 on Clay Pipe. Anson Marston, Chairman.

This report recommends the adoption of revisions in the standard specifications for clay sewer pipe, providing for the inclusion of a higher minimum crushing strength for clay pipe. The committee also recommends the adoption as standard of the tentative definitions of terms relating to clay sewer pipe. Reports consideration being given by the committee to preparation of specifications covering clay culvert pipe.

Report of Committee C-12 on Mortars for Unit Masonry. J. W. McBurney, Chairman.

This committee has been especially active since its reorganization in 1937 and presents for publication as tentative new specifications for aggregate for masonry mortar. A primer on specifications and tests for masonry mortar together with a draft of proposed specifications for mortar for unit masonry, covering four grades of mortar classed according to durability and strength, are appended to the report as information.

Report of Committee C-15 on Manufactured Masonry Units. D. E. Parsons, Chairman.

This report presents a number of recommendations on standards resulting from a critical review made by the committee during the year.

New specifications for solid load-bearing concrete masonry units are presented for publication as tentative. Revisions are recommended in four specifications covering sewer brick, clay building brick, glazed building units, and non-load-bearing concrete masonry units. Three tentative standards recommended for adoption as standard cover sand-lime building brick, concrete masonry units for catch basins and manholes, and general methods of sampling and testing concrete masonry units. Revisions are presented for immediate adoption in the standard methods of sampling and testing brick and the specifications for load-bearing concrete masonry units.

Papers Appended:

Investigation of Methods of Capping Structural Clay Tile. C. D. Williamson, Rensselaer Polytechnic Institute.

Disintegration of Face Brick by Crystallization of Soluble Salt. J. M. Hardesty, Bell Telephone Laboratories, Inc.

Effect of Water Absorption and Strength on Resistance of Bricks to Abrasion. J. W. McBurney, National Bureau of Standards.

Presents and discusses data resulting from measuring abrasive loss on approximately 50 bricks selected to cover a wide range of properties and representing all commercial methods of forming and a variety of materials. The revision of A.S.T.M. Tentative Specifications for Sewer Brick (C 32-37 T) represents the application of these data. The paper includes a study of the reproducibility of the Kessler abrasive test.

Sonic Method of Determining the Modulus of Elasticity of Building Materials Under Pressure. Leonard Obert, U. S. Department of the Interior, Bureau of Mines.

A new sonic method of determining the modulus of elasticity of building materials is presented, whereby the modulus can be determined while the sample is under pressure.

The results of measurements made on concrete and stone by this method are given. These results are compared with both static and dynamic measurements made by other investigators.

A discussion of the sonic method of determining Young's modulus is given and certain limitations pointed out.

Report of Committee C-18 on Natural Building Stones and Slate. Theodore I. Coe, Chairman.

Thursday, June 29 **8 P.M.** **Fifteenth Session**

Held Simultaneously with Fourteenth Session and Round-Table Discussion on Quantitative Spectrography

Methods of Testing

Report of Committee E-1 on Methods of Testing. W. H. Fulweiler, Chairman.

This report submits for publication a consolidated specification for A.S.T.M. thermometers which includes requirements for all thermometers previously specified in various A.S.T.M. methods. The tentative specifications for sieves for testing purposes are recommended for adoption as standard with certain minor changes. Revisions in the tentative method of test for softening point (tapered ring-and-ball apparatus) are also presented.

The report also contains a brief summary of the activities of the present technical committees on mechanical testing, consistency and plasticity, particle size and shape, density, chemical composition, thickness measurement, interpretation and presentation of data, designation and interpretation of numerical requirements, conditioning, and thermometers and laboratory glassware. A report on the investigative studies being carried on for the committee at the University of Illinois to determine the effects of different speeds of testing upon the yield point, ultimate strength, and other physical properties of metals is appended.

Paper Appended:

Testing of Hydrometers. E. N. Hurlburt, Taylor Instrument Cos.

Report of Sectional Committee Z 23 on Specifications for Sieves for Testing Purposes. L. T. Work, Chairman.

Tension Specimen Shape and Apparent Strength. F. O. Anderegg, Owens-Corning Fiberglas, Royal Weller and B. Fried, Ohio State University.

The true maximum stress in a tension specimen may be considerably different from that indicated by the test result due to the non-uniformity of stress over the failure section. A photoelastic investigation indicates that fairly long, slender test specimens are to be preferred. When it seems desirable to use a figure-8-shaped specimen, as in testing cement, very large connection factors are necessary unless the point of load application is made some distance from the center of the specimen. When that is done, a more nearly uniform distribution of stress across the section is secured.

Rockwell Hardness of Cylindrical Specimens. W. E. Ingerson, Bell Telephone Laboratories, Inc.

A theoretical method for correcting the apparent Rockwell hardness numbers obtained on cylindrical specimens using the ball penetrator is developed. The deviation of apparent from true hardness is found to vary linearly with the depth of impression for a given specimen diameter.

Experimental results of tests on specimens from ⅛ in. to 1 in. in diameter of various materials using the Rockwell hardness "B," "F," and "G" scales are presented. The variation in apparent hardness measured on flat and curved surfaces is found to check the theoretical difference, in general, closer than 0.5 of one Rockwell number.

Analysis of Rockwell Hardness Data. R. L. Peek, Jr., and W. E. Ingerson, Bell Telephone Laboratories, Inc.

An analysis has been made of the Rockwell hardness test which serves (*a*) to correlate readings made with different loads and ball diameters, and (*b*) to simplify the relation between hardness and tensile strength measurements.

Experiments are reported in which samples of various materials of several tempers were tested with different loads and ball diameters and the tensile strength of the specimens subsequently determined.

The results indicate the possibility of:

1. Calibrating the Rockwell tester with a single test block, using various loads and ball diameters.
2. Setting up specification limits for hardness measurements corresponding to tensile strength limits.

Stress-Strain-Time Characteristics of Materials. Glenn Murphy, Iowa State College.

Describes a method for presenting on a single diagram the stress-strain relationships for varying rates of loading, the strain-time relationships for varying stresses, and the stress-time relationships for varying strain, thus giving an indication of the behavior of a material under any combination of stress, strain, or time. Properties of a material, such as elastic strength, ultimate strength, resistance to impact loading, and creep limit for various amounts of total deformation, also may be evaluated from the characteristics of the diagram which is the surface developed by plotting along the three coordinate axes values of stress, strain, and time from loading tests on the material.

Description of the surface developed from tests on lead is given, together with a discussion of the determination of the properties from the diagram.

A Study of the Influence of Speed on the Torsion Impact Test. O. V. Greene and R. D. Stout, The Carpenter Steel Co.

This paper is a continuation of a study reported before the Society in 1933 in a paper by Luerssen and Greene on "The Torsion Impact Test." The data in the present paper are the result of experiments conducted at various speeds and at the same energy level. Since conventional slow static torsion tests showed a lack of agreement with impact results when their torque-strain diagrams were integrated, it was felt that the difficulty might be due to the familiar characteristics exhibited by martensite under slow loading. The speed of the static torsion test was therefore increased to a point at which the integration of torque-strain curves showed a good agreement with torsion impact values. The conclusion is that the torsion impact test is in reality a rapid static torsion test.

Load Weighing and Load Indicating Systems, an Historical Account of Their Development with Particular Reference to Materials Testing Devices. Chester H. Gibbons, Baldwin-Southwark Corp.

The evolution of weighing systems is traced historically from the early balances of ancient civilizations through the "steel yard" of the Middle Ages to lever weighing systems of early materials testing machines. The development of alternative devices for load evaluation, particularly over the past seventy years, is considered in some detail.

As suggested, this paper is primarily historical, little or no adventure being made into the controversial phases of the relative merits of the various devices.

A bibliography assists those who desire to pursue the subject more thoroughly.

Photoelastic Analysis of a Prestressed Beam. F. O. Anderegg, Owens-Corning Fiberglas, Royal Weller and B. Fried, Ohio State University.

With the aid of photoelastic analysis it is shown that the total prestress on a reinforced ceramic beam is equal to the total loading stress when the compression in the bottom fiber is just neutralized. At that stage, the directions of principal stresses are displaced 10 deg. and 80 deg. from the vertical and horizontal directions, respectively, so that the principal shears will then make angles of 35 and 55 deg. on the opposite side of the vertical. Advantages of prestressing include immediate use of the steel as soon as load is applied; more effective use of the ceramic material so that a smaller section is needed; and noteworthy increase in stiffness.

Friday, June 30 9.30 A.M. Sixteenth Session
Cement, Concrete, Lime, Gypsum

Report of Committee C-1 on Cement. P. H. Bates, Chairman.

A method for determining the soundness of portland cement by means of an autoclave test is presented for publication as tentative, and a test for specific gravity of cement is recommended for immediate inclusion with the general physical test methods. A revision in the specifications for high-early-strength cement provides for the elimination of the requirement for final setting time.

The report includes a summary of the extensive work carried on by the subcommittee on methods of chemical analysis in investigating new and improved analytical procedures. Studies of methods for determining free lime, phosphorous pentoxide, manganic oxide, sodium and potassium oxides, and quick methods for other oxides are reported. Two new alternate methods for determining free calcium oxide in portland cement and clinker are presented for publication as tentative.

Results are reported of a second series of cooperative tests by 161 laboratories on a sample of cement designated as reference laboratory sample No. 2. The test results cover chemical determinations, compressive strength and other physical tests.

Specific Surface and Particle Size Distribution of Finely Divided Materials. M. N. States, Central Scientific Co.

Summarizes the fundamental principles involved in the Wagner method for the measurement of specific surface and particle size distribution of finely divided materials. General forms of the working equations are derived. The working equations for portland cement studies are shown to follow from the general relationships, and an apparent minor discrepancy in the Wagner expression for specific surface is indicated. The resolving power of instruments which function on the Wagner principle is discussed, and an expression of this quantity is derived, making possible a comparison among instruments which make use of the Wagner procedure.

A description of the "Photelometer" is given and a technique described for its use.

Measurement of Average Particle Size by Sedimentation and Other Physical Means. Pierce M. Travis, Travis Colloid Research Co.

The question of measuring particle sizes below the No. 325 screen of pigments, mineral aggregates, fillers, etc., is becoming more necessary for proper control work in meeting the specifications on finished products. The applications and interpretations of results in research work show a need for a method which will give average particle sizes in percentage below the range of the mechanical screen and in the zone just above the colloidal sizes.

A sedimentation apparatus by which this can be accomplished with results comparable with the microscopic are described and illustrated.

Report of Committee C-7 on Lime. James R. Withrow, Chairman.

This report discusses the activities of the committee and subcommittees during the year and announces that the subcommittee on lime for the chemical industries is reviewing a number of comments and suggestions received concerning the test for available lime by the rapid sugar method, published as information in the report of the committee last year. An extensive compilation of definitions for lime is also being studied.

The committee joins with Committee C-11 on Gypsum in recommending revisions in the tentative specifications for sand for use in plaster and the presentation of the specifications as revised to the Society for adoption as standard.

Report of Committee C-11 on Gypsum. L. S. Wells, Chairman.

This report recommends the adoption as standard of the tentative revisions published since last year in the standard specifications for Keene's cement and for gypsum plastering, and methods of testing gypsum and gypsum products. This

committee joins with Committee C-7 on Lime in recommending for adoption as standard, with revisions, the tentative specifications for sand for use in plaster.

Report of Sectional Committee A 42 on Specifications for Plastering. W. R. McCornack, Chairman.

This progress report announces the completion of proposed specifications for portland-cement plaster and portland-cement stucco.

Lean Concrete Mixes—a Comparative Study of the Effect of Cement Content and Cement Fineness on Strength, Durability and Volume Change. Ernst Gruenwald, Lone Star Cement Corp.

Concrete mixes with cement contents ranging from 2 to 6 bags cement per cubic yard are investigated for concretes of 2 and 6-in. slumps.

Data are developed to indicate the effects of finely ground cements on the properties of concrete by using three portland cements of specific surface areas of 1700, 2100, and 2500 and two high-early-strength cements of 2500 and 2700 specific surface.

A study of the effect of adding an inert admixture to lean mix is also made.

A Drip Method for Testing the Relative Resistance of Concrete Exposed to Weak Acids. Dalton G. Miller, Charles F. Rogers and Philip W. Manson, University of Minnesota.

The conclusions of this paper are based on results obtained by dripping 0.1 *N* solutions of acetic and lactic acid onto flat slabs of concrete set nearly vertical (17 deg. departure). In some cases paraffin dykes are built across these slabs so that the acid is confined on an area 14 in. long and 1½ in. wide, while in other cases laboratory slabs are cast with slightly depressed panels 14 in. long and 1½ in. wide. The rate of flow is controlled by adjusting the heads on glass capillary tubes calibrated to deliver 2 liters of acid each 24 hr. per channel. Each channel is brushed with a steel brush about the size and shape of a 1-in. paint brush and the loosened material is caught in filter paper lined 5½-in. funnels, oven dried and weighed.

Friday, June 30 2 P.M. Seventeenth Session

Held Simultaneously with Eighteenth Session

Concrete (continued)

Report of Committee C-9 on Concrete and Concrete Aggregates. F. H. Jackson, Chairman.

This report includes a new pH method of test for determining organic impurities in concrete aggregates and a revised procedure for determining soundness of aggregate by use of magnesium sulfate.

As a result of a critical review by this committee of the standards under its jurisdiction, recommendations are presented for the adoption as standard of twelve tentative specifications and methods of test, and revisions for immediate adoption in six standards.

A report on "A Statistical Analysis of Compression Tests on Mortar Cylinders, Cubes, and Prisms," prepared by H. W. Leavitt and H. A. Pratt of the Maine Technology Experiment Station appears as an appendix.

Papers Appended:

Some Observations of the Water Vapor Permeability of Concrete. H. J. Barre, Iowa Agricultural Experiment Station.

In one of two methods employed small concrete tanks constructed with special precast units were filled with water and subjected to ordinary room conditions of temperature and humidity. The inside surfaces of some of the tanks were treated with different kinds of paints. The water in the tanks especially in those without treatment disappeared with surprising rapidity.

In the other method, concrete specimens were subjected to a constant difference in vapor pressures on the two faces of the specimen. The amount of moisture permeating the specimens was condensed on a cold surface and collected. The results show that even high strength concretes are permeable to water vapor.

An Investigation of Methods for Measuring the Passage of Water Through Concrete. W. M. Dunagan, Iowa State College.

Modified Procedure for Testing Concrete Aggregate Soundness by Use of Magnesium Sulfate. Charles E. Wuerpel, U. S. Military Academy.

A tentatively proposed method designed to supplant the present A.S.T.M. method for testing the soundness of concrete aggregate by means of a sulfate crystallization test is presented in detail. The new procedure eliminates the use of sodium sulfate and restricts the test to use of magnesium sulfate as the crystallization medium. The detailed procedure is prefaced by a discussion of the principal features which are at variance with the present A.S.T.M. Tentative Method of Test for Soundness of Aggregates (C 88-37 T).

The Effect of Variations in Method upon the Results of Freezing and Thawing Mortars. Bert Myers, Iowa State Highway Commission.

The effect of four different freezing-and-thawing treatments upon mortars made from four brands of cement are reported. It is shown that the relative degrees of soundness of the cements as indicated by transverse strength, compressive strength and surface disintegration varied with variations in the method of freezing and thawing.

The need for research work to correlate the effects of laboratory freezing-and-thawing tests with the effects of natural weathering is indicated.

Selection of Aggregates for Concrete Pavement Based on Service Records. Curtis Cantrill and Louis Campbell, Kentucky Department of Highways.

Presents the service record of various aggregates as indicated by a condition survey of 1100 miles of concrete pavement, constructed by the Kentucky Department of Highways, 1919-1937. This investigation was undertaken in order to obtain essential facts concerning the selection of aggregates when exposed to weathering conditions. Principal features covered are:

1. The aggregate combinations that have resulted in pavement failure.
2. The aggregate combinations that have resulted in satisfactory pavement.
3. The relative decrease in flexural and compressive strength of concrete made from various aggregates when subjected to artificial freezing and thawing.
4. Standard tests which will eliminate aggregate that has an unsatisfactory service record.

The Effect of Biot's Modulus on Transient Thermal Stresses in Concrete Cylinders. Gerald Pickett, Kansas State College.

Transient thermal stresses may or may not be of importance, depending upon the method by which concrete specimens are heated or cooled in making laboratory soundness and durability tests. It is believed that the many factors, the effects of which were previously unknown, may be combined into an equivalent Biot's modulus. Methods of determining, experimentally, the numerical value of this modulus are explained. The mathematical equations of transient thermal stresses as functions of Biot's modulus are derived.

Thermal Volume Change and Elasticity of Aggregates and Their Effect on Concrete. T. F. Willis and M. E. DeReus, Missouri State Highway Dept.

Describes the methods and results of exploratory tests made in preparation for an investigation of the elastic properties and thermal coefficient of expansion of concrete aggregates commonly used in Missouri, and of the effect of these characteristics of the aggregates on mortar and concrete made from it. Included are:

(1) A description of apparatus and methods used.
(2) A discussion of the accuracy of the measurements.
(3) Results of measurements of modulus of elasticity and thermal coefficient of expansion of (*a*) specimens of limestone, chert, quartzite, granite, basalt and sandstone; and (*b*) specimens of mortar, made from three cements and crushed sands derived from limestone, chert, and quartzite.

Report of Committee C13 on Concrete Pipe. Theodore Doll, Chairman.

This report recommends the adoption as standard of the tentative specifications for concrete irrigation pipe.

Informal Report of Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. A. E. Lindau, Chairman.

Miscellaneous Business.

Friday, June 30 2 P.M. Eighteenth Session

Held Simultaneously with Seventeenth Session

Non-Ferrous Metals

Report of Committee B-1 on Copper and Copper-Alloy Wires for Electrical Conductors. J. H. Foote, Chairman.

Submits proposed new tentative specifications for figure 8 and figure 9 deep-section, grooved copper trolley wire for industrial haulage and a review during the year of the various specifications for copper wire and cable for which the committee is responsible.

Report of Committee B-2 on Non-Ferrous Metals and Alloys. E. E. Thum, Secretary.

Reports the completion of extensive changes in the standard specifications for solder metal and includes a brief summary of the activities of the subcommittees on refined copper, zinc, and nickel alloys, precious metals, white metal alloys, and coated metals.

Report of Committee B-5 on Copper and Copper Alloys, Cast and Wrought. C. H. Greenall, Chairman.

This report includes results of the extensive activities of the committee since its reorganization a year ago. Five new specifications are presented as tentative covering, respectively, leaded brass sheet and strip, copper-nickel, and copper-nickel-zinc alloy sheet and strip, beryllium copper sheet and strip, rod, and wire, forging brass, and nickel-silver casting alloy. A classification of cast copper-base alloys for foundry purposes, prepared as an aid in the preparation of specifications, is also included. A number of improvements are presented in 8 standards and 6 tentative standards. Of the latter, 4 are recommended for adoption as standard.

Paper Appended:

Nomenclature and Classification of Cast Copper and Copper-Base Alloys. Sam Tour, Lucius Pitkin, Inc.

Some thirty years ago, the steel industry became very active in the development of alloy steels. Nickel, chromium and vanadium bearing steels soon became popular. These alloys, together with carbon, constituted the major additive elements to the base metal iron. Soon molybdenum additions became popular also. Out of the multitude of possible combinations of these five elements with iron there grew a need for a standard classification. This paper presents a suggested nomenclature and classification of cast copper and copper-base alloys.

Service and Life of Non-Ferrous Tubes in Petroleum Refining. E. S. Dixon, The Texas Company.

Petroleum refining necessitates the use of large numbers of condenser and heat exchanger tubes in contact with corrosive liquids and gases.

Type of failures, composition of alloy used, and comparison of life of various alloys in service are given. Brief mention is made of methods other than selection of particular alloy, such as water treating, cathodic protection, and removal of oxygen.

Report of Committee B-6 on Die-Cast Metals and Alloys. J. R. Townsend, Chairman.

Revisions are presented in the tentative specifications for lead and tin-base alloy die castings to provide an increased range of 80 to 84 per cent tin and 4 to 6 per cent copper. A revision of the tentative specifications for magnesium-base alloy die castings includes the addition of a new alloy XIII, and minor changes in the composition and properties of alloy No. XII.

The committee has obtained samples of five lead- and tin-base alloys on which tensile strength tests by three laboratories and creep tests by two laboratories are being made. The samples will be analyzed spectrographically by four cooperating laboratories.

The chemical composition and results of tests for original physical properties of the metals included in additional exposure tests being undertaken this year on 3 zinc and 4 magnesium alloys are contained in the report.

Paper Appended:

Magnesium Alloy Die Castings. A. W. Winston, The Dow Chemical Co.

The die-casting practice for magnesium alloys has been developing rapidly in recent years. Present production methods and alloys are described, by means of which sound castings of high quality and excellent properties are obtained. As production costs are in a range competitive with those of other die-casting materials, many new fields of application are opening up for magnesium die castings.

Report of Committee B-7 on Light Metals and Alloys, Cast and Wrought. Sam Tour, Chairman.

The report includes new tentative specifications for aluminum-base alloys in ingot form for die castings; also completely revised specifications for aluminum for use in the manufacture of iron and steel, and for aluminum ingots for remelting. A thorough review of the standards for which this committee is responsible resulted in the completion of revisions in five tentative specifications for aluminum-base alloys and in one specification for magnesium-base alloy. The specifications for magnesium ingot and stick for remelting are recommended for adoption as standard.

Report of Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys. Dean Harvey, Chairman.

New methods of testing nickel and nickel-alloy wire and ribbon for electronic tube filaments are presented for publication as tentative. A detailed review of standards under the jurisdiction of the committee has resulted in presentation of revisions for immediate adoption in two specifications for alloy wire and shapes for resistors, the test for change of resistance with temperature and the accelerated life test of electrical-resistance materials. Adoption as standard is recommended of four methods covering tests for linear expansion, flexivity of thermostatic metals, bend testing of wire, and temperature-resistance constants.

Spectral Emissivity (at 0.65μ) of Some Alloys for Electrical Heating Elements. W. F. Roeser, National Bureau of Standards.

Measurements of the spectral emissivity of a number of commercial heating element materials were made to obtain data needed for the measurement of the operating temperature of alloys during life tests. Inasmuch as the Society's Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys is contemplating life tests in various atmospheres, emissivity measurements were made both under oxidizing and reducing conditions. In air, the results are characteristic of the oxide formed. In highly purified hydrogen, the values obtained are characteristic of the unoxidized metal except in the cases of alloys containing aluminum. In hydrogen not highly purified, alloys containing chromium acquire a coating of oxide which differs from that formed in air at high temperatures.

Report of Committee E-2 on Spectrographic Analysis. H. V. Churchill, Chairman.

A progress report discussing considerations being given to the three existing tentative methods of quantitive spectrochemical analysis of non-ferrous metals. Reports plans for the symposium to be sponsored by the committee following a round-table discussion at the annual meeting to consider the various fundamentals of excitation, photometry, and various other phases of spectrochemical analysis with the purpose in view of establishing master methods for qualitative and quantitative analysis.

The Spectrographic Analysis of Tin. J. Warren Stewart, Carnegie Institute of Technology.

Previous works on the quantitative spectrographic analysis of tin are discussed and their shortcomings indicated. The logarithmic sector wedge method is described, and data are given concerning the excitation conditions and general procedure. The selection of spectrum lines and the preparation of working curves are discussed, with special reference to the preparation of standard samples. Working curves for the analysis of antimony in concentrations between 0.01 and 0.5 per cent, bismuth between 0.001 and 0.1 per cent, copper between 0.001 and 0.05 per cent, iron between 0.001 and 0.1 per cent, and lead between 0.01 and 0.5 per cent in tin are illustrated. The method used in measuring spectrum lines is given.

Report of Committee E-3 on Chemical Analysis of Metals. G. E. F. Lundell, Chairman.

A progress report discussing completion during the year of the methods of sampling and chemical analysis of ferro-alloys and reviewing the work under way on analytical procedures and sampling methods for the non-ferrous metals and alloys. Recommends the adoption as standard of the methods of chemical analysis of ferrous metals and presents revisions in methods for chemical analysis of pig lead, aluminum, and electrical-resistance alloys.

The Determination of Silicon in Certain Aluminum Alloys Containing Silicides. Thomas A. Wright and John Jicha, Lucius Pitkin, Inc.

The determination of silicon in aluminum alloys is not the simple matter it is too often thought to be. Certain of the main reasons therefor are discussed and the historical development of an appreciation of the fact is outlined and commented upon. Cooperative work of eleven laboratories on two 5 per cent silicon alloys is given, and the effect of magnesium in a series of heat-treated 5 per cent silicon alloys is discussed indicating that magnesium alone is not necessarily a factor in causing loss of silicon hydride when the acid method of decomposition is used. The paper presents reasons why the caustic method of decomposition is to be preferred to the present A.S.T.M. mixed acid method as a general practice.

Miscellaneous Business.